ELECTRICAL REVIEW

SEPTEMBER 1956

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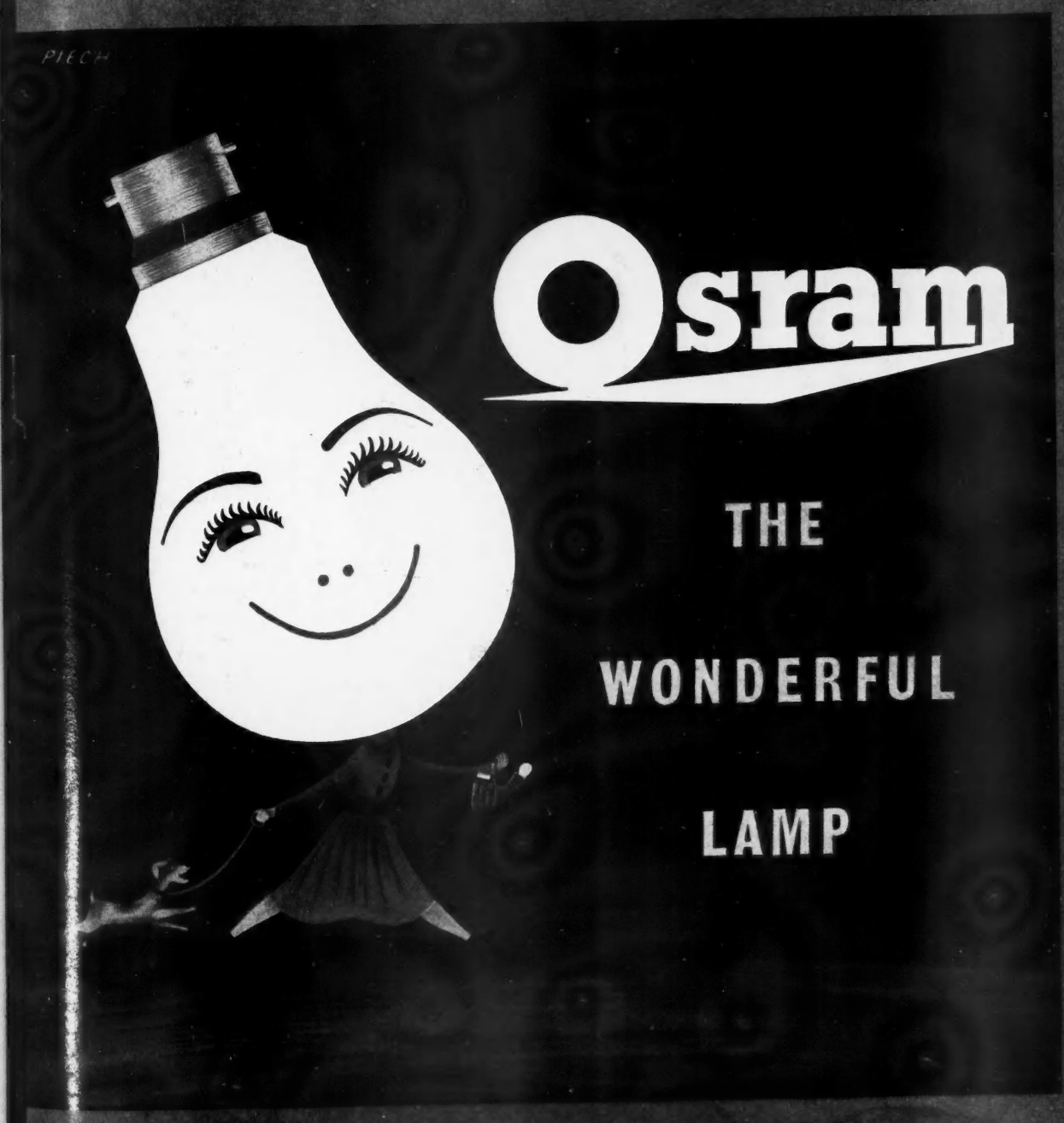

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ELECTRICAL REVIEW

Managing Editor: HUGH S. POCOCK, M.I.E.E.
General Editor: J. H. COSENS
Technical Editor: P. W. TUCKER, M.I.E.E.

7 SEPTEMBER 1956

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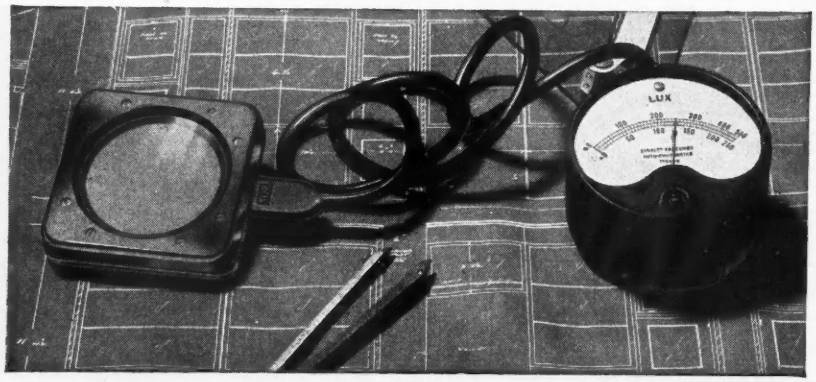

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ELECTRICAL REVIEW

7 September 1956 Vol. 159 No. 10 Established 1872

Tie-Line Power Control

FURTHER investigations into the possibilities of direct-current transmission, reported from Sweden, Japan and the U.S.S.R. at this year's C.I.G.R.E. meeting in Paris, support the view that substantial scope will exist for its employment in a future not so far distant as seemed likely only a few years ago. The earliest examples will no doubt be found in under-water work, in which the high cost of a.c./d.c./a.c. convertor stations would be offset by the value of the greater power-carrying capacity of d.c. cables.

Experience with the Sweden-Gotland 60-mile d.c. transmission of 20 MVA at 100 kV appears to indicate that the construction and operation of larger convertors for higher voltages are likely to prove less expensive and to offer fewer technical difficulties than it was once feared. That much seems a reasonable deduction from the estimates of comparative costs of high-voltage a.c. and d.c. transmission by overhead and underground cable which were worked out afresh and presented at C.I.G.R.E. by Mr. F. J. Lane (C.E.A.) in association with Swedish engineers. Many details, both technical and economic, remain to be cleared up, but the broad picture that emerges augurs well for the future.

A Japanese paper described plans not only for d.c. links between the islands which constitute Japan but also for overland circuits for interconnecting systems operated at frequencies of 50 and 60 c/s. This introduces another factor, which had previously been referred to in the preliminary particulars of the proposed Franco-British tie-line given at the Institution of Electrical Engineers in 1954 by Messrs. D. P. Sayers, M. E. Laborde and F. J. Lane. The authors recognised the possible value of a d.c. link as enabling power flow to be regulated independently of the frequency and voltage of the two large nation-wide a.c. networks, which would be connected by a cable of a relatively small carrying capacity but otherwise the most suitable in the circumstances. The considerable net savings expected from the cross-channel scheme could be achieved only through continuously reliable operation which with a.c. would entail the installation in Britain, as already in France, of automatic control equipment. By the use of d.c., $2\frac{1}{2}$ times the amount of effective power could be transferred between the two countries, the original three-phase scheme having provided for a spare cable.

The calculations in the Anglo-Swedish C.I.G.R.E. paper indicated an intersection of the cost curves for a.c. and d.c. cable transmission of 100 MW at 21 miles, whereas the cross-Channel distance is 24 miles; the Japanese paper estimates the critical distance at an appreciably lower figure. From the announcement by the C.E.A., reported on a later page, it appears that frequency control is a determining factor in the final choice of direct current.

NUCLEAR FUSION

In his presidential address at last year's Conference on the Peaceful Uses of Atomic Energy Dr. H. J. Babha (India) predicted that within the next two decades a method would be found for liberating atomic fusion energy in a controlled manner. He said that when that happened " the energy problems of the world would be solved for ever." British representatives at the Conference (of whom Sir George Thomson, F.R.S., was one) were inclined to take a more cautious view of the possibilities, although they did not dispute that controlled atomic fusion would eventually be achieved.

At the British Association meeting last week Sir George Thomson mentioned the work which was being done here and in the United States and Russia on the commercial use of the energy released in the reaction between the nuclei of deuterium (heavy hydrogen) which was the basis of the hydrogen bomb. He said that he had no doubt that the process would be " tamed " in the not-very-distant future although whether it would be better than the use of uranium and thorium was not certain. He believed that the nuclear reaction of deuterium offered better prospects for the direct derivation of electricity—without the interposition of a " heat engine."

"MONOPOLIES" REFERENCES

One of the purposes of the Restrictive Trade Practices Act, 1956, is the reconstitution of the Monopolies and Restrictive Practices Commission on a smaller scale and the removal of the latter part of its dual title. In the meantime the Commission has been directed by the Board of Trade to complete its work on four references which it has in hand, including that covering electronic valves and cathode ray tubes. It is noted, however, that no action will be taken under the 1948 Monopolies Act as a result of the Commission's reports on any agreements subject to registration under Part I of the 1956 Act. Three other references are being allowed to lapse; two of them relating to street lighting equipment and electric batteries. The Monopolies Commission had also been given a direction to investigate common price and agreed tendering. As these subjects are now dealt with by the Restrictive Trade Practices Act they will be taken out of the Commission's hands.

TOTAL ENERGY OUTPUT

In his article " Private Generating Plant " in the *Electrical Review* of 17th August Mr. A. J. Ellison stressed the importance to the nation of the conservation of fuel by correctly balancing the heat and electricity outputs of private generating plant run in parallel with the public electricity supply. This is a most difficult question to discuss without implications relating to the very old question of private generation *versus* public electricity supply in the sense of competition between one system and the other.

The author said that if an industrial undertaking using low-pressure steam installed a back-pressure turbine and generator, and obtained much more useful output, in heat and electricity, from the coal burned, the problem of how best to use the electrical power immediately arose. That, of course, is fundamentally true of any private generating scheme where there is an attempt to co-ordinate the heat and electricity output, but where private generation and public supply run in parallel the problem of fuel conservation is a much more delicate one.

As the author pointed out, the Central Electricity Authority announced in 1953 that where the use of private generating plant would contravene the provisions of an existing supply agreement, the consumer would be offered a new contract which, while reflecting the costs of connection and supply, would leave him free to use his private plant to the best advantage. But to the best advantage of whom? That of the firm concerned, of the public supply authority or of the nation?

NIGERIAN PROGRAMME

Great endeavours are being made by the Nigerian Government to strengthen and develop the economy of the Federation. Like many other nations, Nigeria has a five-year plan, covering the period 1955-60, and the programme aims at providing adequate communications, higher education and fundamental research, social services and public utilities and services in Lagos. One of the statutory bodies which is to receive financial assistance by way of loans is the Electricity Corporation of Nigeria. The requirement of the Corporation in 1956-57 is put at £3 million and for the period 1955-60 at £7·17 million; consequential commitments after this period are estimated at £1·5 million. To finance the programme recourse will have to be made to overseas lenders, particularly the London money market; it is hoped to raise a total of £30 million in this way.

The July-September issue of the official *Nigeria Trade Journal* contains statistics of trade during the first quarter of the year. These show that imports from the sterling area had a value of £20·1 million (United Kingdom £16·9 million) and those from the non-sterling area £14·7 million. Electrical machinery and apparatus (£1·3 million) represented 3·8 per cent of the total value of imports but about 17·5 per cent of the machinery imports. Electrical trade showed a 39 per cent increase as compared with the first quarter of 1955. Generally, the United Kingdom is Nigeria's best customer and principal supplier. The trade runs in favour of Nigeria but there has recently been a diminution in the favourable balance.

ELECTRIC COOKERS

The next in our series of illustrated surveys of domestic electrical equipment (*Electrical Review*, 14th September) will deal with electric cookers. Particulars to be given in tabular form will include details of type, size, oven loading and control, hot plates, grill boiler, storage drawer, special features, finish and price, etc. On 5th October electric fires will be reviewed.

Seaside Illuminations

SOME PROBLEMS OF A DISTRICT MANAGER

By J. LINTON, A.H.W.C., M.I.E.E., Assoc.I.Mech.E.*

THE manager of a district of an Electricity Board which includes a large seaside town has, in addition to his usual duties, calls made upon him to provide an attractive and original illumination scheme to bring visitors to the town during the late summer and early autumn, and therefore to prolong the season, a task which lasts the whole year through. The illuminations are no sooner switched on than he has to turn his attention to variations which must be played on the same familiar theme for the next year. He has also to concern himself, during the many weeks when the seafront glitters and shines with the results of last year's work, with the problem of providing from an already over-worked staff sufficient men to maintain and repair the many set-pieces and the thousands of lamps which have been employed. In short, the engineer's lot, like that of Gilbert's policeman, is not a happy one.

When the Southend Corporation, twenty-one years ago, decided to illuminate a stretch of the seafront which was then about 2½ miles long, they visualised something more than a display of coloured strip lighting, and in deciding that the extensive shrubbery gardens along the lower cliffs should be illuminated and decorated in the manner of "Never Never Land," they laid the pattern, and a very sound pattern it was, for future years. Since 1935 the changes have been rung innumerably, but the basic plan is still the same; thousands of gaily coloured lights, mass floodlighting of the gardens and the building and setting of those fanciful and fairy-like characters which still populate the imaginations of all children, whether they are at school or grown up.

This year's display at Southend-on-Sea is, I believe, as good as any of its predecessors, and it has meant constant work for a section of the staff of the Southend District of the Eastern Electricity Board throughout the whole of the preceding twelve months. The Southend Corporation, who are the owners of the illuminations and everything which goes with them, have been our customers ever since the nationalisation of the industry, and the relationship between Board and Council is such that I am given a very free hand in providing the best possible display, following agreement on my suggested scheme and estimated costs. It is more than just another job of work for the District; to many of the staff it is a labour of love because they are

The Never Never Land Waterfalls

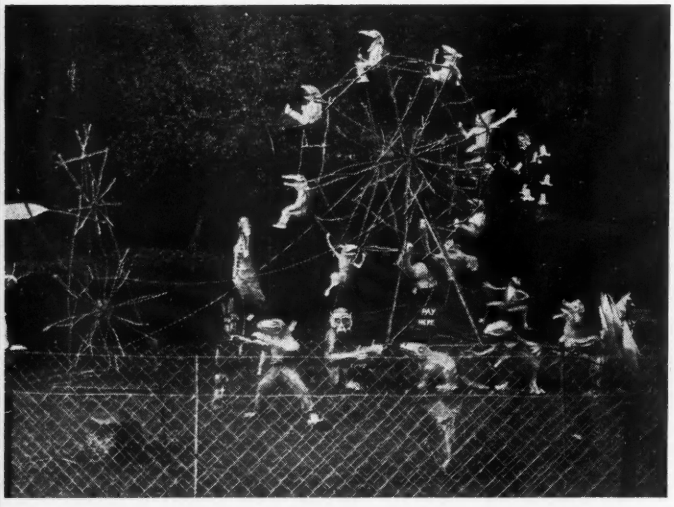
* Manager, Southend District, Eastern Electricity Board.

General view of the seafront illuminations at Southend

intensely interested in what they are doing. While the little figures and set-pieces on which they perform are made up by professional artists, their design and the general scheme for employment are the work of the Board employees. There is also co-operation between Southend and places like Morecambe, Sunderland and Royal Leamington Spa which, on varying scales, use illuminations and fairyland figures to attract visitors, for the exchange of items, but in the main the new pieces are home designed and planned.

Supply for the lights and for the various mechanisms involved is taken from several points of the low-voltage system of the town, controlled by heavy-duty three-phase ironclad switch-fuses, whilst the various connections are made by means of temporary t.r.s. and v.i.r. cables. The lamps at present being used for the strip lighting are all of 15 W and are of a special type, internally coated with colour. It has been found that externally sprayed lamps are of little use, because the colouring matter flakes off and the colour changes under the impact of weather. We use 40,000 of them, or 75,000 if we include the illuminations on the pier. Every year we have to replace a large number, and while I must admit that the majority of " duds " result principally from mechanical failure of the filaments, I think manufacturers ought to endeavour to produce a much more robust lamp, even if a little less efficient, able to stand up to the rigours of the atmosphere and use and capable of retaining their colour, and at the minimum price. Where small lamps are required to provide colour effects use is made of natural coloured glass envelopes, but as these are much more expensive they are kept to the minimum.

The Ferris Wheel



Before the war there were some set-pieces erected in lifeboats moored offshore, power being supplied by gutta-percha-covered cables, the insulation of which becomes more effective when immersed in sea water. Consideration is being given to repeating this experiment, probably next year. For the lighting of the gardens 200, 300, 500 and 1,000 W projector and wide angle flood-lamps fitted with coloured screens are employed. Fluorescent tubes are used in conjunction with these lamps, for it has been found that flood-lamps of the filament type are alone insufficient to throw objects into proper relief. Fluorescent tubes, for example, can light up the whole of the interior of a tree. Considerable experiment was necessary before a proper balance of fluorescent and filament lighting was achieved. It was found that with green fluorescent tubes, one tube was sufficient; in the case of blue two and sometimes three were required, while for yellow and red three tubes had to be employed in most cases.

The illuminations can be roughly divided into two parts. There is the colourful strip lighting arranged in festoons supported on large illuminated pylons and augmented by decorative lanterns, along about a mile and a half of the front, which can be seen and enjoyed free by every visitor. There are also several set-pieces as focal points in these decorations, and to attract attention they are generally arranged so that groups of lamps are continuously switched on and off, to simulate movement. These decorations are, however, only the prelude or the invitation to the second

and perhaps more important part of the display, to view which a small charge is made. This second part is centred in the shrubbery gardens, and consists of such set-pieces as Pigmy Fair, the Teddy Bears' Picnic, the Never Never Land railway, Birdcage Walk, the Animal Ferris Wheel, the Jungle Hotel, together with many others. All these display pieces are operated mechanically by virtue of a variant of the cam and the eccentric driven by a small electric motor. Although the operation is more mechanical than electrical, it demonstrates the versatility of the electrical engineer if it does nothing else.

As an innovation, set-pieces in the shape of large television screens about 9ft by 8ft are illuminated and peopled by mechanical puppets in the form of the children's television favourites, Muffin, Hank, Andy Pandy and the Flower-Pot Men, and occupy strategic positions in the display, the whole being so arranged that the public are encouraged to proceed in one direction from attraction to attraction. The paths, as one would expect in a shrubbery garden, are winding and sometimes tortuous, and they therefore have to be well illuminated and provision is also made for loudspeaker crowd control. In addition, in order to inculcate some road sense into the children and, perhaps, the adults, illuminated traffic signs of the standard type are used at frequent intervals.

Many years ago it was realised that suitable background music was a great inducement in keeping crowds on the move in these gardens; at first this was provided by amplifying tunes from a glockenspiel, but when this wore out records were employed. Now we have moved forward and a tape recorder has been brought into use, and suitable recorded tunes are reproduced.

As I said earlier, some part of the staff of the District is employed all the year round on the decorations and the lighting, and much of their work is done under difficulty. The Ferris Wheel, for example, has to be re-erected, repaired and put into working order in what little space can be found in the workshops of the former power station; buildings of all descriptions all over the town are used to store the working pieces, and their renovation and maintenance have to be carried out there. At least a dozen men work on repairs, alterations and overhaul during the winter and early spring, but the number has to be increased to about thirty for erection during the summer months. During the period of the display itself, seven men are constantly employed on maintenance and repair.

One of the display pieces showing the operating mechanism

The work of designing and maintaining the decorations and illuminations at a seaside resort like Southend-on-Sea, even though it occupies the staff on and off continuously, is accepted as part of the general plan of giving the public, who buy and use electricity, a good service. And because it is also a job in which a great deal of personal interest can be taken, it does much to strengthen the camaraderie between the staff of the District and of the Corporation.

NEW BOOKS

Public Address and Sound Distribution Handbook. Advisory Editor, Alexander J. Walker. Pp. 160; figs. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 21s.

In dealing with valves and their associated circuits as applied to audio amplification, the first chapter discusses the subject and presents it in a manner that should assist operating and maintenance engineers to grasp some of the fundamental theories. Circuits of a representative number of public address amplifiers are given, accompanied by notes on features of the design. The chapter concludes with an account of some of the high fidelity amplifiers that are more closely associated with home music reproduction.

Details of microphones, pick-ups, loudspeakers and other apparatus that constitute a system are given in the second chapter but more attention could have been given to the fundamental qualities that are necessary in these elements when designing a system that is required to give the optimum results.

The many aspects of installation are covered in the next chapter to a degree that is adequate for the scope of this book and includes the basic requirements that have to be fulfilled when making connections to Post Office lines. Attention is also drawn to the subject of licences for the reproduction of recorded music and to the desirability of third party insurance.

With the exception of cathedrals and churches, the fourth chapter reviews almost all the uses for public address systems and particular attention is given to the requirements of hotels, schools and theatres. The publication concludes with maintenance and servicing, and gives useful information on batteries, charging and vibrators. Intimation of the more common faults of a system are given, with methods that might be adopted to rectify them.

For the less experienced person this book presents an informative guide to the subject but it would have been desirable to have been given more of the fundamental aims of the art of sound reinforcement. References to technical papers and other publications would have helped the discerning engineer seeking further knowledge of some of the more specialised aspects.—J.L.G.

Analysis of Electric Circuits. By William H. Middendorf. Pp. 306; figs. John Wiley & Sons, Inc., New York; Chapman & Hall, 37, Essex Street, London, W.C.2. Price 48s.

The author presents a textbook on circuit analysis based upon his classroom experience, and which is thus rather a lively and interesting account of the subject. For the same reason it does not cover any one year of the usual British educational courses. The nearest approximation is perhaps the first-year undergraduate course, but the material would have to be selected with care. The book is divided into three sections—basic circuit analysis, its extension, and specialisation into polyphase power and communication circuits.

The six basic laws of the early experimentalists—Coulomb, Kirchhoff, Ohm, Faraday and Lenz form the foundation of the first section, and indeed of all circuit analysis. The various types of voltage and current variation are described and a sign notation is propounded. It is an asset to have the notation defined, especially since that used for voltage differs from the one in normal use in this country. Before attempting to analyse any circuit the

algebra of complex numbers is presented and definitions of circuit parameters and methods of calculating powers are explained. The performance of a single branch composed of a single parameter when a current or voltage is applied to it, occupies a whole chapter. This is followed by series and parallel circuits and their mutual transformation. The author deals with alternating current conditions entirely, leaving the direct current operation as a special case of zero frequency.

Locus diagrams introduce the phenomena of resonance, and the mesh and nodal methods of solving networks containing more than one source of current or voltage are briefly reviewed in one chapter. Another chapter covers magnetic field coupling and the air-cored transformer, so concluding Part I.

Part II deals with non-sinusoidal waves and the exponential form of Fourier series in one chapter, and several further network theories such as superposition, Thevenin, Norton and star-delta transformation.

Part III outlines the fundamentals of three-phase power circuits and the approximations which are usually made for communication circuits.—K.W.W.

Radio Valve Data: Characteristics of 2,500 Valves and C.R. Tubes. Compiled by the staff of *Wireless World*. Fifth edition. Pp. 126. Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 4s 6d.

This edition, which is over 25 per cent larger than the previous one, contains full operating data on over 2,500 types of British and American radio valves, 37 transistors, and 300 cathode ray tubes. Nineteen British manufacturers are represented, all of whom have co-operated with *Wireless World* to ensure that the information given is accurate, comprehensive and up-to-date.

Electrical characteristics of each valve are given in the main tables but the base connections are now shown diagrammatically, the main tables being keyed to the series of diagrams. This new method of presentation makes it much easier for the reader to find the information he wants. There are nineteen full pages of diagrams.

The main tables further classify the valves into current, replacement or obsolete types, as recommended by the makers. An index enables any valve to be found immediately in the tables, while the full list of equivalents, a valuable new feature introduced in the fourth edition, has been retained and enlarged.

Vacuum Deposition of Thin Films. By L. Holland. Pp. 541; figs. Chapman & Hall. Price 70s.

This authoritative work, by the head of the vacuum coating research laboratory of Edwards High Vacuum, Ltd., covers a field which up to now has been documented only by scattered papers and works covering a part only of the field. The technique of most importance is in any case that of vacuum evaporation, which has become of commercial importance only in the last decade or so. The present work commences with a thorough exposition of the basic high vacuum techniques: the production of high vacua and the prevention of pump fluid contamination; the degassing of plastic materials, paper, etc.; the design of vapour sources for the evaporation process and their emission characteristics; and evaporation techniques for a range of metals and alloys.

Important applications which are described in some detail include the production of thin resistive films of nichrome and other metals, the deposition of zinc or aluminium metallisation on capacitor tissue, quartz crystal electrode deposition and the production of single and multi-layer anti-reflection coatings and high reflection coatings. The production of optical interference filters is described in detail, and the author has compiled a useful table of the deposition characteristics and refractive indices of a number of inorganic compounds utilised for this purpose. The production of front surface aluminised mirrors is described, also measures for protection of the reflecting surface against tarnishing and abrasion. The metallising of plastics is extensively carried out to-day, both for decorative and optical purposes, and in order to provide anti-static surface conducting films on windows, etc. Electrodes and printed circuits have also been experimentally produced by vacuum evaporation. A chapter is devoted to shadow casting for electron microscopy.

The sputtering process has been known for nearly a century, and the mechanism and suitable layouts are discussed. Its chief use to-day is for the production of metallic oxide films by reactive sputtering. Such films have optical applications, and can also be used as transparent resistance heaters on glass surfaces, and as photocell and rectifier counter-electrodes.

The book is excellently produced. The techniques are well described, whilst some theoretical background is given, and there are frequent references to the bibliography of 557 references.—P.L.D.

Abacs or Nomograms. By A. Giet. Translated by J. W. Head and H. D. Phippen. Pp. 225; figs. Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 35s.

The average engineer who uses nomograms if presented in a reference book, rarely understands the basis of their construction, and never constructs his own. This is mainly due to the fact that the comparatively small literature on the subject is written for mathematicians and is rather difficult for the practical engineer to understand. M. Giet presents an essentially practical book explaining abacs or charts of several varieties and giving examples from engineering practice—mainly machine shop and mechanical engineering problems.

A review of diagrams, or graphs as they are more commonly called, and the scales which may be used, forms the first section showing the relationship between two variables.

Cartesian abacs, or "families of curves" for three variables, are the starting point of a section which is concluded by showing how such abacs may be constructed to show the relationships between "n" variables.

The major part of the book is devoted to describing alignment charts based upon parallel co-ordinates. This section starts from first principles and really gives a clear idea of the basis of such charts. It is shown how to combine charts, and how to use auxiliary variables. A short chapter on alignment charts based upon non-parallel co-ordinates and another showing the relationships between "n" variables conclude the mathematical part of the book.

A most useful appendix gives the relative advantages and disadvantages of the charts described in the book—the main advantage of the cartesian abac being that it is still useful after tearing in half! Miss H. D. Phippen and Mr. J. W. Head have made an excellent translation and conveyed M. Giet's ideas in a very clear manner.—K.W.W.

Mechanical Design for Electronic Engineers. By R. H. Garner. Pp. 223; figs. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 25s.

Mr. Garner feels, quite correctly, that young engineers are more at home with electrical design than they are with the mechanical aspects of their profession, and he has written this book to guide them and as an aid to mechanical standardisation. As a matter of fact, the title is rather misleading because the book is a sort of "Ingenious Mechanisms for Engineers and Designers" devoted to the electronics industry. Many of the mechanical "piece parts" available for the construction of racks, chassis and bays of equipment are illustrated and described.

Of design, in the accepted sense of starting out from a theoretical analysis of the specific problem and proportioning the apparatus so as to fulfil the initial requirements, there is practically nothing. In the chapter on ventilation, for example, it might be expected that one could find some rules for determining the necessary cooling in a given equipment. This is not so, but there is a nice photograph of a range of proprietary fans. An extremely irritating feature is that where tabular data are given, for instance on "special" magnetic materials (p. 195), these are confined to the products of one manufacturer. If such tables are to be of value they should be comparative. There are some curious omissions, e.g. spot welding is not mentioned, nor are wrapped connections.

It is a pity that indifferent execution has marred a book which would have been of great value.—A.H.B.

Mineral Separation by Electrical Methods

Use of High Tension Equipment

By A. E. WILLIAMS, Ph.D., F.C.S.

THE use of high tension electrical equipment for the separation of minerals in the mining industry which has been evolved in recent years is a natural development from the old-established electrostatic methods. Since high tension separation is an outgrowth of electrostatic separation, for clarity's sake it is necessary to draw a comparison between the two methods. While the term "electrostatic" implies that no current is flowing, high tension methods make use of a very high rate of discharge, and electron flow and gaseous ionisation play a major part.

Electrostatic separation has been applied to ores of various types for over fifty years, but recent applications in the mineral field have not been numerous, due very largely to the satisfactory application of other methods. Another factor limiting the use of electrostatic methods is their restriction to dried feeds in a range size of 20 to 250 mesh, which means that in numerous cases the raw mineral material has to be dried before it can be treated, while the grain size limits its application to definite mineral deposits. No successful application of electrostatic separation of dust-like materials has been made. A number of successful applications have been made when the material was dry, and the grain size correct, and these plants are still in operation separating minerals and other materials by the use of high voltage.

There are three basic types of machines. Firstly, the toboggan type in which the feed slides down a grounded chute in front of a charge electrode. Secondly, machines which make use of a shaking table which has charged electrodes over it. The greatest success, however, has been achieved with the third type in which the minerals are fed on to a rotor which serves both as an earth and as a feeding mechanism, providing an even layer of material in front of an electrode. The rotary motion of this machine enables much higher outputs to be obtained than are possible with tables or toboggan types. It is with the rotary type machine that progress has been made from purely electrostatic to high tension methods.

Lifting Effect

The purely electrostatic rotary machine is based on the so-called "lifting effect" principle, and the first mineral separation processes using high voltage were of an electrostatic nature, employing charged fields with little or no current flow. The particles of mineral assumed a surface charge from heat and friction or were charged during the separation by voltage from a discharging source. Particles so charged were conveyed into a charged field and were attracted to an electrode of opposite charge and/or repelled from an electrode of like charge. Since a very small amount of force was available to cause the materials to move in different directions so that they might be separated, a small amount of material was separated in a single pass, and consequently a number of passes had to be employed to yield a high percentage of separation.

The "lifting effect" can be defined as the attraction of particles of one charge toward an electrode of the opposite charge (Fig. 1a). By the use of this lifting effect, materials which have a tendency to become charged with one or another definite polarity may be separated from each other even though their relative conductivity may be very similar. For example, quartz very easily assumes a negative charge and may be separated from other poor conductors by an electrode carrying a positive charge. This electrostatic type of separation has only a low efficiency, and is sensitive to humidity, temperature and grain size.

A large proportion of the commercial applications of electrostatic separation of minerals has been made by using the "pinning effect" (Fig. 1b). This occurs when the minerals receive a spray discharge of electricity which gives some of the material present a high surface charge and causes them to be "pinned" to a grounded rotor. For example, if a mixture of minerals of various susceptibilities to surface charge is fed into a spinning rotor and sprayed with a high-voltage discharge, the particles of relatively poor conductivity will assume a charge and be attracted to and pinned to the rotor. Particles which have a relatively high conductivity will not assume a charge easily and what little they do receive will readily leak off to the grounded rotor.

These particles of better conductivity, therefore, follow a flight path similar to the one they would follow if there were no charging effect at all. In pinning, the polarity of the charging electrode is of little or no consequence since the charge given to the particles is necessarily opposite to that of the rotor. In a truly discharging electrode there is no lifting effect from attraction due to charge, and the separation is not static in nature since some flow of current must exist.

High tension separation makes use of the pinning effect to a very high degree and in some cases may combine both a strong pinning with some lifting effects. Experimental work has proved that with very high rates of electrical discharge to the grounded rotor, as for example when making a separation in a field of very strong corona discharge, almost complete separation between component minerals of the feed occurred during a single pass over one rotor even at high feed rates, and there was little or no effect on the separation by changes in humidity, temperature or other

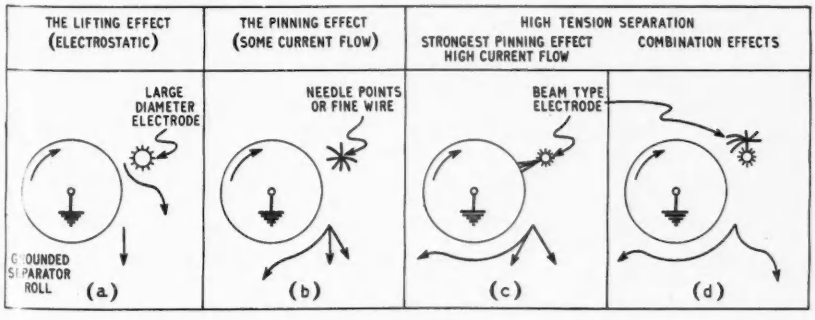


Fig. 1.—Diagrammatic arrangement of grounded separator rotor working in conjunction with various types of electrodes

disturbing factors common to electrostatic separations.

In order to create this very dense high-voltage discharge, a beam type electrode is used (Fig. 1c). It consists of a fine wire adjacent and parallel to a large diameter electrode which is in mechanical and electrical contact with it. This fine wire, not more than 10 mils in diameter, tends to discharge readily and if used alone would have a normal radial discharge pattern. The large member of the dual electrode tends to have a short, dense, non-discharging field. This combination of the large diameter part of the electrode which has a non-discharging field and the small diameter of the electrode which has a discharging field creates a very strong discharge pattern which may be "beamed" in a different direction and concentrated to a very narrow arc. The effect on the minerals of the feed passing through the beam is very strong and is no doubt due largely to gaseous ions which are created by the high-voltage gradient in the field of the corona.

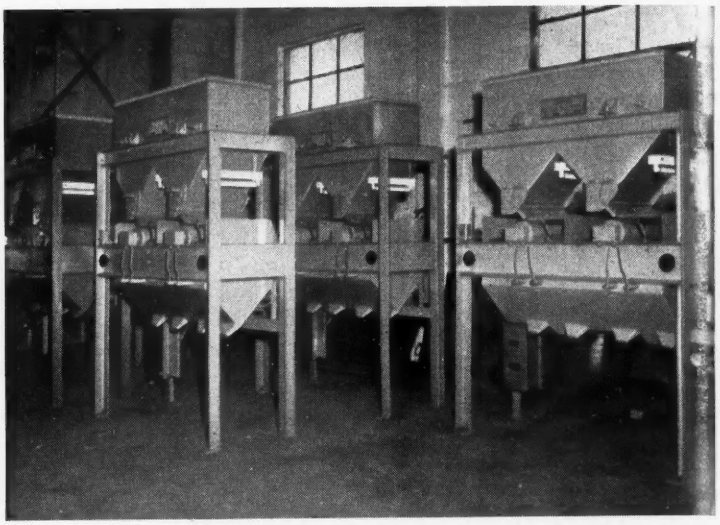


Fig. 2.—Group of four-rotor high tension separators before shipping to Malaya for cassiterite separation

By rotating the electrode (Fig. 1d) around the axis of the large diameter, the pinning effect of the electrode may be stopped completely. In other words, if the beam which does the pinning is rotated away from the material conveying roll of the separator, all of the pinning action is cancelled. The large diameter electrode will then exhibit a lifting effect, principally on the minerals of relatively high conductivity. Combination effects of pinning and lifting are used wherein the electrode is placed so that the wire performs a pinning effect on the poorer conductors, and then the large diameter portion gives a lifting effect on the mineral grains of comparatively higher conductivity.

These high tension separators are being produced as small compact units (Fig. 2), each consisting of four rotors, 6in in diameter and 6ft long, working in parallel. The material to be separated is fed on to the rotors through a slot orifice to give an even blanket of material on the rotor. The beam type electrode is set normally at about the 2 o'clock position from the rotor with the beam or corona pointed towards the rotor. A high enough rate of speed is given to the rotor to cause considerable bouncing and slipping, at and following the point of contact when the feed hits the rotor. This turbulence is desirable since the materials not in contact with the grounded rotor assume surface charges more readily. Materials split into two fractions as a result of the high tension field.

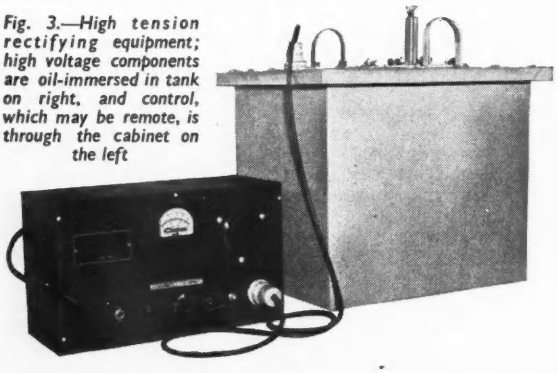


Fig. 3.—High tension rectifying equipment; high voltage components are oil-immersed in tank on right, and control, which may be remote, is through the cabinet on the left

In addition to the conductor and non-conductor fractions, in most cases a middlings or re-circulating load fraction is taken. The existence of this fraction is due to entrainment of grains during separation, and it is usually returned and combined with the feed to the separator. In typical separations where heavy sand-like minerals are separated, each rotor has a capacity of about 2½ tons of total feed per hour per four-rotor machine. The latter machine uses two ¾ h.p. motors, each of which drives two rotors.

The separators are equipped with variable speed d.c. motors, controlled by rheostats on the front panel of the machine. In the multiple rotor machines the high voltage needed is connected by an insulated lead from a rectifier to a round aluminium busbar fastened to the machine frame on stand-off insulators; individual hook leads carry the current from the busbar to the end of the beam electrode.

Rectifying Equipment

When the high tension separators were first tried out it was found that high-voltage rectifying equipment specially designed for high tension separation was necessary. A pulsating d.c. voltage of high peak form with no capacitive or inductive smoothing effect is by far the most efficient. Rectifiers which use condensers as voltage doublers are not normally employed, for reasons of safety. With poorly regulated transformer design or ballast circuits, the high peaks of voltage tend to be squared off and separations are very much impaired. Electronic oil-immersed rectifiers designed for high peak waveform, with controllable voltage and controllable current output, which will stand up to continuous service without trouble from dust or moisture, have proved to be satisfactory.

In the rectifying equipment used (Fig. 3) the high-voltage components are completely oil-immersed in a steel tank, thus they are not affected by dusty mill conditions, high operating temperatures or humidity. The maximum output of the equipment is 40 kV peak and is usually set for 20 mA output current at dead short circuit. These units employ a two-tube full-wave circuit and have a capacity of sixteen 60in high tension separator rotors, or approximately 80,000 lb of mineral feed per hour. By a combination of the standard design of high-voltage transformers and limited tube emission, the rectifier circuit

has been "balanced" to produce stable operation under normal separation loading, but to have a carefully limited current output when short circuited. This output current is limited to predetermined settings and cannot exceed them regardless of what conditions of short circuit may exist. This feature ensures safety to the operators together with full access to the separation equipment.

To protect the equipment, a self-timing relay is incorporated in the control circuit which will not permit high voltage to reach the rectifier tubes until the filaments have had sufficient time to heat up. A holding relay is fitted in the control unit to prevent surprise appearances of high voltage following power failures. In order for the rectifier to produce high voltage the holding relay must be closed by operating the momentary contact switch on the control unit. The control and safety devices are assembled in the separate metal cabinet which may when needed be situated remotely from the rectifier. The relays, meter and metering switch, output current control, and voltage control continuously variable from zero to 40 kV maximum peak output are incorporated in the one cabinet. A circuit diagram of the control units for the rectifier is given in Fig. 4.

The rectifier unit is earthed before being put into operation, and the control unit is automatically earthed through the control cable. The meter on the front panel of the control unit has two scales. With the metering switch in the right-hand position marked "d.c. voltage," the meter indicates the rectified d.c. voltage available at the output terminal. This voltage is read on the upper scale marked "output kilovolts peak." With the metering switch in the left-hand position marked "a.c. input," the meter indicates the a.c. voltage of the power supply and is read on the lower scale of the meter marked "input volts."

Both output current and output voltage are functions of the input voltage. If the input voltage fluctuates to a large extent, a source of constant voltage may in some cases be warranted; when necessary, a constant voltage transformer can be used. In large installations, however, where a number of rectifiers are operating on a single source, motor-generator sets are found to be very satisfactory for a constant voltage supply.

Trouble sometimes arises when a rectifier is being used in connection with magnetic separators, through surge voltages being fed back from the load into the rectifier. The nature of such surges has to be investigated to provide a basis for elimination of the trouble. The most common trouble of this type results from inductive surges which may be built up in any large magnet to which the rectifier may be connected. In such an instance it is necessary to allow the rectifier tubes to warm up properly before closing the magnet switch. This will prevent premature intermittent current flow which may result in inductive surges. Installations using automatic demagnetising equipment occasionally have trouble due to the surges stored up in the magnet when the circuit is broken. These surges may be imposed upon the rectifier an instant later when the switch again closes. A bleeding resistor across the magnet, to absorb these surges, usually corrects the trouble.

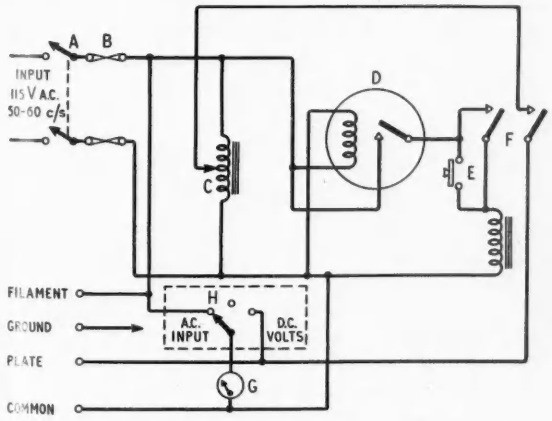


Fig. 4.—Circuit diagram of control units for the high voltage rectifier

As already mentioned, when the high tension rotors are in operation some of the material being separated is "pinned" to the rotor as a normal method of separation; the degree to which the material clings to the rotor in this way varies with the nature of the mineral. In some cases the material may be removed from the rotor by means of a felt wiper which is held in place tightly against the rotor by a torsion spring, the tension of which may be screw-adjusted. However, there are many instances wherein a mechanical aid such as a felt wiper cannot release the securely pinned material. In cases of extreme pinning which lead to brushing difficulties, the machines are fitted with an electrode under the rotor which electrically removes the material from the rotor. The electrode works in conjunction with scraper brushes, the electrode neutralising the charge which is pinning the material to the rotor, while the brushes remove the material and drop it in a hopper. The non-conductor material adheres to the rotor because of the charge received from the large direct current beam electrode. This charge is neutralised by alternating current discharged from a small wiper electrode. This electric wiper system consists of a transformer and one small beam electrode per rotor. The electrode is held in position by thumb screws and may be adjusted when necessary to suit different materials.

Experimental Work

These high tension separators are much in use in connection with the almost frantic search for minerals to be used in the field of atomic energy, and for experimental work small models of the commercial separators are employed. In such tests, the material is passed over the feed rotor and the separation characteristics noted as conditions are varied. In general, the higher the voltage used the higher the degree of separation when only pinning is done, the electrode gap being kept at the minimum distance where no sparking occurs. If the rotor speed is too low, all of the material will be pinned to the rotor. Rotor speed is then slowly increased through the variable speed motor to ascertain whether or not one mineral is thrown from the rotor more readily than the others. By looking along the face of the rotor directly under the stream of materials leaving the rotor, the colour of the material being pinned may be observed. This is often an important factor in determining the optimum speed for a clean non-conductor fraction.

If satisfactory separation is not attained by varying the speed of the rotor, or a better separation seems possible, conditions may be altered to achieve the desired effect. The separation corona may be changed in both intensity and voltage. Electrode positions are often very critical, especially when combining lifting and pinning effects. The polarity of the high voltage will normally have no effect on pinning separations, but it may exert influence on materials lifted from the rotor when an electrostatic field is created. Generally speaking, the most important factors to be considered when making difficult separations are rotor speed, the point at which the feed is brought on to the rotor, feed rate, voltage and position of the beam

electrode. In cases where the feed is constituted by minerals of fairly high conductivity and minerals of quite low conductivity, the highest degree of separation is made by using the highest voltage possible, the highest rate of electrical discharge to the rotor possible, and the highest rotor speed at which the bulk of the non-conductors are pinned to the rotor.

If the material to be separated is made up entirely of minerals of low conductivity, then separation in an electrostatic field is worth investigation, and in this case the rotor speed is limited to between 10 and 100 r.p.m. The electrode is rotated so that the fine wire is pointed directly away from the rotor, and the electrode position in respect to the roll may be as low as 3 o'clock. In handling non-conducting minerals the electrode may be placed very close to the rotor without any danger of sparking, and normally no pinning effect occurs. One or another of the minerals may be attracted or to some extent depressed by the electrode, so that a separation is gained. In such cases both negative and positive polarities are tried with the electrode to see which produces the highest separation.

In many parts of the world at the present time numerous low-grade deposits of minerals are being investigated which were previously regarded as unprofitable, and it is thought that high-voltage separation will find increasing use in this sphere of low-grade, high-tonnage metallurgy.

TESLA CENTENARY

Celebrations in Yugoslavia

NIKOLA TESLA, the great Serbian scientist, was born on 9th July, 1856. Among the things that we owe to him are three-phase current and the principle of electromagnetic resonance; consequently his influence on electrical engineering has been enormous. Tesla's centenary was recently celebrated in Yugoslavia and Professor R. O. Kapp, B.Sc., M.I.E.E., who was one of the foreign guests on the occasion has provided us with some notes on the celebrations. The Yugoslav Government had sponsored a national committee with Professor Damianovitch of the University of Belgrade as secretary. This committee asked over fifty scientists from more than twenty countries to attend the celebrations, and in most instances wives were invited to accompany their husbands. After a number of meetings in Belgrade a tour of the country was organised with Professor Zepic, University of Zagreb, as leader.

The first reception was held in Belgrade on the actual anniversary of Tesla's birth and was followed next morning by a session at which tributes to the work of Tesla were paid in short speeches by official representatives of major international scientific organisations, national bodies and universities. Sir Arthur Fleming conveyed a message from the Institution of Electrical Engineers and Dr. Dunsheath, as president of the International Electro-Technical Commission, happily used the occasion for the first public announcement of the news that the Commission had, at its meeting in Munich during the preceding week, resolved to recommend the name of Tesla for the M.K.S. unit of magnetic field strength—a unit often called the weber per sq metre in this country.

The subsequent programme in Belgrade included eighteen short lectures devoted to Tesla's work and to developments that had sprung from it. The first of these was delivered by Professor Niels Bohr. Other lectures were given by Sir Arthur Fleming and Professor Kapp, while there were lectures by American, Czechoslovakian, French, German, Hungarian, Russian and Swedish scientists. There were visits to the Tomb of the Unknown Soldier, beautifully situated on the top of a hill in the vicinity of Belgrade, to some nuclear research laboratories and to the Tesla Museum. There were a number of official receptions and also a visit to the opera. One of the receptions was given by Marshal Tito, who conversed fluently in French and German with some of the guests and in quite good English with the three English visitors.

A tour of the country following the celebrations in Belgrade included visits to some large copper rolling mills in Sevogno, the Litostroj turbine factory in Ljubljana, the Rade Koncar electrical factory in Zagreb, the Jablanica power station not far from Sarajevo and the Nikola Tesla power station at the northern end of the Adriatic. Five of the six 31,000 h.p. Francis turbines in the Jablanica station, their alternators and transformers, and some other items of electrical equipment were manufactured in the above-mentioned works.

The Nikola Tesla station works at a head of over 2,000ft and is equipped with 28 MW Pelton wheel turbines. It employs a restricted amount of pumped storage. The lake from which the water is drawn is rather small, but there is a much larger lake a few miles distant and at a level some 180ft higher. To avoid waste of water, when the lower lake is getting full, water is pumped to the higher one and allowed to return as and when required.

Industry in Yugoslavia is still very much in its infancy. Indeed, a serious beginning was only made after the Second World War and at a time when the ravages of that war had also to be overcome. What has been achieved in such a short time and in the face of such formidable difficulties is really impressive. The rapid build-up of manufacturing capacity in a country that was almost wholly agricultural less than ten years ago made it necessary for factory equipment to be as simple as possible. There is no automation and material is man-handled more than in the older industrialised countries as there has not yet been time to train men in the art of operating and maintaining complicated automatic plant.

Professor Kapp commends the excellence of the arrangements and says that the visitors were made to feel that this was a gathering of good friends, united by common scientific interests and by a common admiration for the genius of Tesla.

Plant Engineering Conference

THE Incorporated Plant Engineers are holding a Southern Regional Conference at the Grand Hotel, Bournemouth, from 12th to 14th October, the theme of which will be "Future Developments in Plant Engineering." The programme will include papers on "Industrial Noises and their Effect upon Production," by Mr. D. M. A. Mercer, and "The Making of a Plant Engineer in the Industrial Age Ahead," by Mr. J. Wilson. Social events will include a theatre party at the Pavilion and a dinner and dance at the Grand Hotel. A coach tour has been arranged for the ladies. Those who wish to attend can obtain full particulars from Mr. W. R. Selwood, organising secretary, Chandlers Ford, Southampton.

Wire and Cable Factory

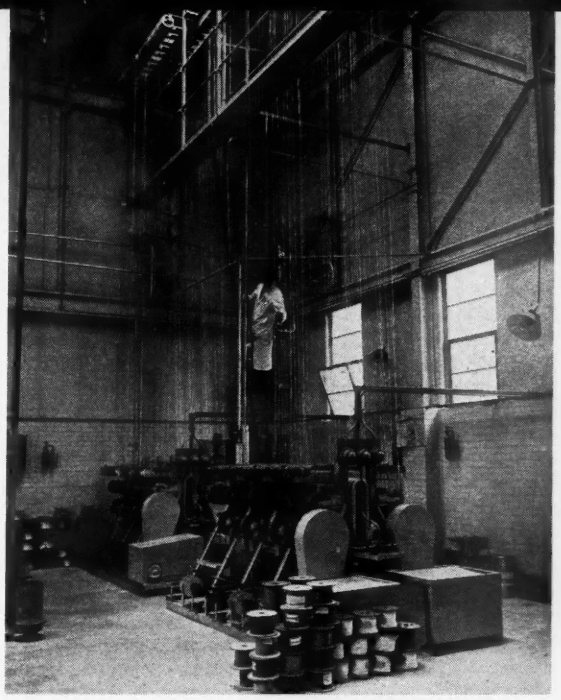
NEW WORKS OF THE L.P.S. ELECTRICAL COMPANY AT ST. LEONARDS-ON-SEA

AT the end of May the Duke of Norfolk, Lord Lieutenant of Sussex, officially opened the new and well designed works of the L.P.S. Electrical Co., Ltd., at St. Leonards-on-Sea, which form part of Hastings Corporation's light industrial estate.

Before the building of this new factory the company had its principal manufacturing plant at Alperton, Middlesex, where it was formed 43 years ago. Small offshoots grew up in scattered premises in the Hastings area; all these, together with the activities previously carried on in Middlesex, are now concentrated in the new works, and the other places have been disposed of. The company moved in twelve months ago but the changing-over and putting into full service of the new works is only just nearing completion.

One reason for choosing the Hastings area was the reasonable supply of suitable labour and this has been found much more stable and plentiful than it was in London. A condition of engagement is a refusal of re-employment of staff leaving for seasonal work at holiday times. About 500 people work in the new factory and up to 800 can be employed when development is complete.

Among the principal activities of the company are the cotton and silk covering of wires for telephone and low-voltage applications; making up numbers of these into multi-cores for telephone use; telephone connector cords; v.i.r. cables of the usual sizes for voltages up to 250 and t.r.s. cables; various types of p.v.c. and polythene insulated cables; and television downlead cables. Pre-formed wiring assemblies and rubber mouldings of plugs and cable are also made.

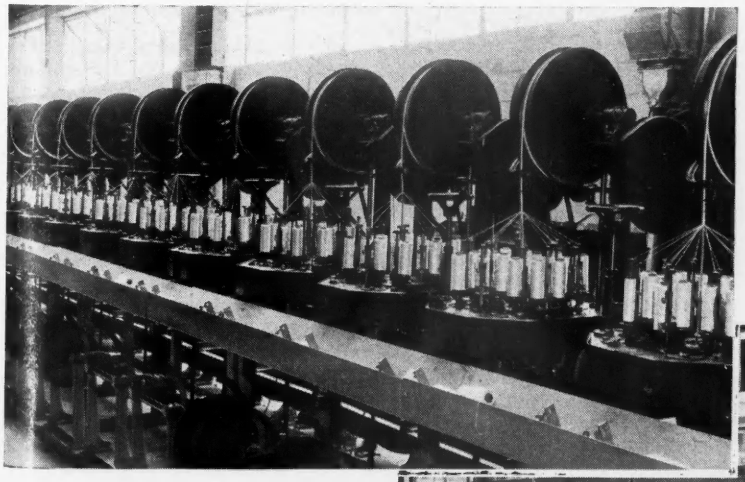


Lacquering cotton covered wire

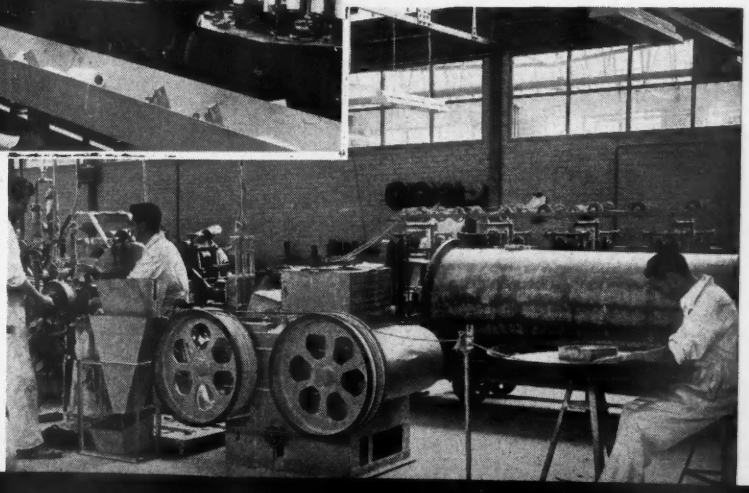
In the new works there are about 500 braiding machines used for putting cotton or metallic covering on wire. An interesting item made on machines designed and built by the L.P.S. Co. is "technical tinsel" for use in telephone cords. Circular wire is rolled flat and lapped round individual strands of cotton. These are then roped together to produce an extremely flexible cord.

Rubber cable is made in a special shop. At present, rubber is extruded on to the wire which is reeled up and put into a large tank for vulcanising, a process taking about 45 minutes. Plans are in hand, however, for installing a covering machine with its own continuous vulcanising chamber. This makes speeds of 5,000-10,000 yd of finished v.i.r. an hour possible. It is also proposed to build a rubber preparation house adjoining this shop; at present rubber is received in sheet form.

A separate building houses the lacquer plant where cotton-covered wire is coated with lacquer to make it fire-resistant—a requisite in many installations. Paradoxically, the lacquer is highly inflammable when wet and all equipment in this room is flameproof. A somewhat similar machine paints an identifying helix of a different colour on self-coloured plastic cables.



A row of braiding machines putting a metallic layer on insulated wire



The outer rubber covering of t.r.s. cable is extruded on to the core

PROGRESS OF SCIENCE

British Association Meeting at Sheffield

THIS year's President of the British Association was Sir Raymond Priestley, M.C., until 1952 principal and vice-president of the University of Birmingham. He chose as the subject of his address to the meeting which started at Sheffield on 29th August, "Twentieth-Century Man Against Antarctica." In this he dealt with the history of exploration in the Antarctic continent, which started a little before 1900 with landings on the more accessible shores. Soon after the turn of the century the first permanent Antarctic weather station was established by the Swedes.

Lately many scientific and engineering aids had come to the assistance of the exploration work. The use of radio-sondes, seismic profiling of inland ice formations and the use of aircraft were quoted as examples. Sir Raymond pointed out that a better understanding of the long period of climatic changes dependent upon Antarctica was important at the present time. If the ice sheets of the world melted in a hurry the sea level would rise something like 100ft. He felt that great and valuable mineral deposits must exist in a continent the size of Antarctica, but so far nothing of significance had been found. Prospecting on a continental scale, let alone the exploitation of any discoveries, would be so costly that it would require finance and organisation at least on a national scale to ensure success.

Airborne magnetometers and stereoscopic-camera mapping were already in use in Antarctic surveying and future exploitation lay with the co-ordinated use of airborne surveyors carrying out wide sweeps, and of helicopter-borne ground parties equipped for high-speed core drilling and rock sampling.

Physics and Technology

Section A this year was under the presidency of Sir George Thomson, F.R.S., who in his address discussed the relations between physics and technology. He said that the real influence of physics upon technology started with electricity: from its beginning electrical engineering had been directly dependent upon scientific discovery. He felt that physics also owed a debt to modern technology because the progress of this had given physicists the machines without which progress in their science would have been impossible, an example of this being the vacuum pump.

Shortly before the war there were very few physicists in industry but now the number was increasing exponentially. He spoke of the most recent instance of the way in which modern physical knowledge was being applied to technology, namely, the development of nuclear energy, and he felt that there had been few cases in economic history in which a new discovery had come so completely in the nick of time.

He did not think that there was any fear of the uranium in the world running out. Last year at the Geneva Conference it was stated that a million tons of uranium had already been proved and each ton was theoretically the equivalent of three million tons of coal in producing heat. This amount of coal equivalent would last the world for many years. In the long run he thought that it would be possible to make commercial use of the energy released between the nuclei of deuterium and there was more possibility of deriving electrical energy direct from the nuclear reaction in this case than in the case of uranium. Such a system would avoid the inefficiency of the heat engine which now interposed.

After speaking of electronic computers and the development of the transistor as examples of co-operation between physics or mathematics, and technology, he referred to the satellite which the United States hoped to send up in the International Geophysical Year which starts in 1957. This was an admirable example of the interplay of physics and technology. On the one hand its immediate purpose was to make measurements outside the earth's atmosphere, and on the other hand it was the first stage in what was hoped would be the overcoming of gravity in the sense of making it possible for man to leave the earth and visit other planets.

The satellite would be launched by a three-stage rocket and it was hoped that when the last stage had finished firing it would be moving at a height of about 300 miles round the earth with a speed of nearly 18,000 m.p.h. It ought, ideally, to be able to stay up for a matter of weeks, during which time it would be sending messages to the earth of the measurements being taken of radiation of all kinds. It might be possible to verify experimentally some of the laws of relative gravitation.

Oil and Industry

The presidential address to the Engineering Section was delivered this year by Mr. A. C. Hartley, C.B.E., who took as his subject the oil industry of the world.

The first natural oil well was discovered in the United States in 1859 and soon afterwards crude oil was being produced in many countries. Throughout its history the oil industry had been among the foremost in encouraging the development of promising new engineering discoveries. The first successful pipeline, built in the early 1870's, was 2in in diameter with screwed joints and had a length of six miles. Steam-driven pumps delivered about 70,000 gallons a day.

By 1930, 112,000 miles of pipeline were in operation. The pipelines delivered oil to storage tanks where all-welded steel tanks were now the common practice; some of more than 20,000 tons capacity were being built. Fixed roofs were used for heavy non-volatile oils but steel roofs floating on the oil were now used for crude oil and for light oil, to reduce loss by evaporation and fire risk. Cathodic protection was frequently applied to prevent corrosion of the tank bottoms, and tanks were carefully insulated from the pipeline to prevent increased corrosion if they should become anodic to the pipeline system.

During the last sixty years, the period of growth of the internal combustion engine, oil consumption had grown from eight million to seven hundred million tons a year. During the same period coal consumption had increased from 500 million tons a year to 1,700 million tons a year. On the subject of world oil reserves, Mr. Hartley said that those capable of production under existing conditions of extraction were currently estimated at 25,000 million tons and this would be exhausted by about 1975 according to the figures he had already quoted. However, taking into account the actual recoverable reserves and those known to exist outside the so-called proven areas, recent data suggested that the estimate might well be 140,000 million tons. The production experience of the industry had been that the rate of discovery of new reserves was always

considerably higher than the rate of extraction. Large amounts were still awaiting discovery in the potential oil-bearing areas of the world.

Oil, he said, had played a great part in the development of agriculture by making mechanisation possible. Before 1914 very few tractors were available, but by 1952 there were about seven million in use throughout the world. The most important contribution to industry was perhaps the provision of 90 per cent of the lubricants without which no machine could survive. A hundred years ago the only lubricants available were of animal or vegetable origin. Speaking of the interests of Sheffield in the oil industry he said that it had recently been estimated that the oil industry of the free world, excluding the U.S.A., would require 19 million tons of steel during the next five years.

High Temperature Research

Chemistry at very high temperatures was the subject of a paper which was presented to Section B, Chemistry, by Professor George Porter, who said that an important reason for the production of higher temperatures was that they gave greater efficiency in an engine converting heat into useful work.

Because of the very rapid reactions, special research techniques had to be used to study the chemical changes, and one new technique used a shock tube. A second method consisted of irradiating the gas with an intense flash of light. Both methods heated the gas without having to heat the vessel holding it.

When scientists studied substances at these high temperatures they found molecules which were chemically quite unstable at lower temperatures. For instance, the blue light of an ordinary gas burner was nearly all emitted by the diatomic carbon molecule C_2 which was unknown at ordinary temperatures. At these high temperatures, reactions were so fast that the molecules could not keep up and the point was reached at which temperature no longer had a clear meaning.

The great energy liberated in nuclear reactions had opened up new vistas in the production of high temperatures and attached new importance to their study. Nuclear reactions could be initiated by heating a substance, although the temperature required to start nuclear transmutation was much higher than for chemical transformation. The earliest chemists had sought the philosopher's stone for transmuting the elements and in one sense it might be said that in attaining very high temperatures scientists would have the philosopher's stone.

Slow Application of New Ideas

The suggestion that European countries, in spite of possessing leading research schools, were often so slow in developing their own discoveries that they became uncompetitive was made by Dr. Peter McKellar, of the Psychological Laboratory, Sheffield University, when he presented to Section J, Psychology, a paper on the application of scientific research to human living.

He said that human beings were unnecessarily inefficient in making adjustments to scientifically ascertained facts about material nature. They were even more inefficient in adjusting to scientific findings about human nature, despite much lip service to the importance of the human factor in industry.

" With our addiction to the philosophy of ' good enough for my father ' and our sometimes unhealthy respect for ' tradition,' are we not often a bit too slow about applying new ideas? " he asked. " A former scientific adviser to the Ministry of Production, Dr. Alexander King, suggests that we are and comments, ' leaders of American industry claim that their production is derived from a quick recognition of the practical significance of basic scientific discoveries made elsewhere, especially in Europe.' "

Human nature was a complex subject and one about which everybody felt that he had a right to his own opinion. The term " common sense " was frequently used, but unfortunately common sense was often used as a cloak for private fantasy and hostility to a realistic investigation of the facts. In Britain, and in America, a lot of useless research was done; but, equally, much that was useful was written up and then left unopened on the shelves of university libraries. He reminded his audience of the examples of the twin reflex camera and the motor scooter; the Germans and the Italians had not been slow to develop and market these once we had invented them.

Dr. King had said that there were too many scientifically illiterate firms. Certainly the most important factor in productivity was the rate at which new scientific and technical ideas were introduced into industry. This time lag between research and application merited investigation and old research findings needed more attention. Scientific research was invariably hard work and sometimes expensive and we could not afford to waste it. Perhaps there ought to be a Research Institute. Research frustration arising from the fact that work done was too often wasted was relatively common among scientists. The honest business man had nothing to fear from the investigations of his auditors. There was no reason to fear that auditing against the facts of nature which science provided against our private " hunches "—if we were interested in truth.

The author gave many examples of the present time-lag, among them the fact that following the study of a new type of corn, it took five years from the time the farmer heard about it to the time he began to use it. It had been known for 131 years that the dark-adapted eye was markedly insensitive to red. The fact that pedestrians who wore red at night were inviting death should be pointed out to them vigorously and often. One of the suggestions in business was that to get research into action they should concentrate on times of change of personnel rather than attempt to change persons at present in authority. Thus the new broom would sweep even cleaner.

Hysteresis Loop Tracer

Papers presented by young engineers included one by Mr. R. G. George on control of flux waveform in tracing hysteresis loops. He described apparatus used to trace the hysteresis loops of small diameter ring specimens of magnetic ferrites which had " rectangular " loops. The special feature of his equipment was the provision of means for varying the instantaneous rate of tracing of the loop in any predetermined manner throughout the cycle. This was accomplished by means of negative feedback from the specimen, an amplifier being used to control the flux waveform so that it was a reproduction of a voltage waveform which periodically repeated at a frequency in the range 100 to 15,000 c/s. He also described methods of producing suitable non-sinusoidal control voltages, which might then be applied to the amplifier.

After outlining the general requirements of the hysteresis loop tracer, the author described the flux controlling unit, the magnetising current display amplifier, the integrating amplifier and the control voltage waveform generator. He said that the main advantage of the system lay in its ability to trace a hysteresis loop under almost any desired conditions of rate of flux change. The limitations were the necessity for a large number of turns on each winding on the specimens; the instability with overload; and the low-frequency limit to the accuracy of the system. Nevertheless, the system with appropriate modifications could be used to trace out dynamic characteristics of com-

ponents or apparatus which, due to non-linearity, would distort the test waveform if this were not controlled by the feedback.

Another young engineer, Mr. J. McNeillie, presented a review of boiling heat transfer with particular reference to unstable flow. He pointed out that when heat was transferred from a solid to a liquid and the liquid boiled, a higher heat flux could be obtained, so that boiling heat transfer had many applications where high heat fluxes were encountered. These included liquid propellant rocket motors and radiation heated steam generator tubes and nuclear reactors.

With boiling heat transfer, however, there was a critical heat flux which it was generally unsafe to exceed and which occurred when the surface being cooled became covered with a film of vapour. The paper dealt with the various phenomena associated with boiling heat transfer.

Dealing with pool boiling and the mechanism of boiling, the author said that in nucleate boiling bubbles formed on the heating surface due to the greater liquid superheat there, the presence of potential bubble nuclei and the smaller surface tension at the solid-liquid interface. Little heat was transferred directly into a bubble in contact with the heating surface, the heat passing directly into the liquid. The high heat transfer rates associated with nucleate boiling were due to the disturbance of the laminar sublayer by bubble formation at the heated surface.

He said that surface boiling gave the highest heat transfer rates. A hysteresis effect in boiling had been observed, indicating that more nuclei were active at a given temperature difference if the temperature difference had first been increased to a greater value for an initial period.

The addition of a film of oil to the heat transfer surface had been shown greatly to reduce the heat transfer coefficient, and this was probably due to the insulating properties of the oil film and the change in wettability of the surface.

Secondary Air Control

In a third paper in this group Mr. M. G. Perry took as his subject automatic control of secondary air in combustion. He said that an experimental apparatus for measuring the oxygen concentration of flue gases had been constructed and tested in the laboratory. The meter was activated by the variation in the heat released from a pilot flame burning—with a large deficiency of primary air—in a surrounding atmosphere of varying oxygen concentration. The heat released activated a metallic differential expansion system.

It was generally not practicable to operate commercial plant with the theoretically correct quantity of air, and operation of a furnace with a quantity of air above or below that for which it was designed entailed a loss in efficiency and waste of fuel. An indication of combustion conditions in a furnace could be obtained by measuring the CO_2 or O_2 content of the flue gases, but it was preferable to measure the O_2 content and to base combustion control on it.

For a primary measuring means in an automatic control system, three factors were important—reproducibility, sensitivity and the nature and speed of response to changes in the controlled variable. His experiments showed that the apparatus used was suitable as a primary measuring means for oxygen concentration.

Although it had been hoped that a simple mechanical linkage to the expansion element would be sufficient to adapt the apparatus to an automatic control system for the secondary air on a combustion appliance, in practice it would be necessary to use a pneumatic proportional control system. The apparatus would then be adjusted so that the controller scale was linear. In all his experiments the apparatus had been sensitive to changes in the oxygen concentration of a maximum of 0·5 per cent. It had responded rapidly to changes in the oxygen concentration, 80 per cent of the total movement occurring within three minutes.

Nuclear Metallurgy

The use of such metals as beryllium, niobium, zirconium and vanadium in atomic energy was among subjects discussed by Mr. L. Rotherham when presenting a paper on "Metallurgy of Atomic Energy" to the Mathematics and Physics Section. He said that the uranium fuel in the gas-cooled reactors, such as at Calder Hall, was canned in aluminium and magnesium as a method of preventing the uranium distortion. At Windscale, where air was the coolant, aluminium was used. Work had been done on many aspects of aluminium technology and an aluminium of commercial purity had been produced that was cleaner than any produced for other purposes. Investigations at Harwell had shown that for Calder Hall is was possible to produce magnesium alloys free from serious risk of burning in the pile. Magnesium had a lower neutron absorption cross-section, thicker sections could be used, and with the slightly higher creep strength of the metal some restraint of the uranium was possible. The canning problem was, however, the central problem in the metallurgy of reactors.

In the Dounreay fast neutron reactor, the uranium temperatures were higher and the need for a strong canning material became progressively more important. Steel would have been used more but for its higher neutron absorption cross-section. In the circumstances, the author said, they had had to consider beryllium, zirconium, niobium, vanadium, tungsten and molybdenum.

Where neutron absorption was a vital factor, beryllium and zirconium has advantages, but there were doubts about the ductility of beryllium and since its price was high the conditions under which it replaced aluminium and magnesium had to be considered carefully. The alternative for high-temperature service was zirconium, although its resistance to air and CO_2 attack left doubt whether it could be used at very high temperatures, although it had a possible use in sodium-cooled and water-cooled reactors.

In reactors cooled by liquid metals, beryllium was less resistant to attack by liquid sodium than some metals; aluminium was rapidly attacked; magnesium was unsuitable; and it was doubtful whether zirconium had sufficient strength at very high temperatures. More refractory metals, such as niobium and vanadium, had to be considered for canning, and work done on the former had been promising.

In his paper on the manufacture of titanium, to the Chemistry Section, Dr. James Taylor said that large ingots of titanium were commonplace and the titanium melting furnace had grown into a highly-developed, fully-automatic unit with a surprisingly high electrical efficiency. Most wrought forms of titanium and its alloys were now readily obtainable in this country.

The fact that powder metallurgy has opened up methods for studying a wide range of new materials was stated by Mr. L. D. Brownlee, B.Sc., A.Inst.P., in a paper on the subject presented to the Engineering Section. He said that all the stable carbides, borides and silicides of metals could be studied by these methods. The high melting-point borides of the transition metals of the fourth to sixth groups of the periodic table formed most promising high-temperature materials. Nickel-bonded chrome borides were very good up to 950 deg C. Beryllium was also being fabricated by a powder metallurgy process.

Mr. Brownlee described basic techniques and a typical manufacturing process with molybdenum, used in great quantities in the form of sheet and wire in the thermionic valve industries. Discussing the manufacture of parts

from sintered-iron powder, he said that iron powder suitable for pressing could be made by electrolytic methods, such as the electrolysis of ferrous chloride. Other methods included the carbonyl method. Carbonyl iron was used in the manufacture of magnetic materials and electrolytic iron powder was used for magnets.

Important developments were impending in the harnessing of the wind and the sun, according to Professor A. A. Miller, Professor of Geography in the University of Reading, in the written text of his presidential address to the Geography Section. A day of sunshine falling directly on 100 sq metres, he said, was equivalent to more than 500 kWh, which cost £2 at the cheapest domestic tariff. The possibilities of wind and solar energy had been demonstrated and efficient means would surely be found before long of collecting, focusing, using and transmitting this energy.

The Earl of Halsbury, managing director of the National Research and Development Corporation, opening a joint session between the Economics and Engineering Sections, declared that the public were substantially misinformed about automation. He suggested four items to which the word might apply: transfer machining, automatic assembly, control engineering and data processing by means of computers. If there were a common factor, it was reunification and continuity, although that was not a very satisfactory definition.

Transfer machining and automatic assembly were most likely to affect consumer durables, such as automobiles, refrigerators and vacuum cleaners and the more expensive class of household gadgets which were bought on the basis that they would last five to fifteen years. But consumer durables were always the victims of any fiscal policy designed to reduce purchasing power. Control engineering would apply typically to the chemical industry, but it had been applied there for so long that it was no novelty. Data processing applied largely to accountancy, but primarily to managerial accountancy rather than classical book-keeping. It was in these new types of accountancy that data processing would spread.

Creep Strength of Steels

The improvement in power station performance as a result of the introduction of steels with better creep strength was revealed by Prof. A. G. Quarrell in a paper on the physical approach to metallurgy to the Mathematics and Physics Section. He said that it had been possible continuously to increase the steam temperature and efficiency of power production. In 1923 the steam conditions were 370 deg C and 350 lb/sq in, whereas in 1955 the figures were 570 deg C and 1,500 lb/sq in. That had meant a 27 per cent increase in efficiency.

Some aspects of deformation in creep were adequately explained in terms of dislocations, and predictions could be made about the probable effect of structural changes, but with the highly complex alloys necessary to the best creep performance a semi-empirical approach was still necessary.

A paper on coal-face mechanisation in British mines was given to the Engineering Section by Mr. W. H. Sansom, M.C., O.B.E., M.I.M.E., Mr. A. Scott., B.Sc., M.I.M.E., and Prof. F. S. Atkinson, M.Eng., M.I.M.E., A.M.I.C.E. The authors said that there were opportunities in coal mining for new techniques and developments and for men capable of understanding the sciences which had developed in the industry since the war. Automation might well be a natural outcome of the mechanisation projects being carried out, but owing to the natural conditions of mining it was unlikely to have as wide an application as in other industries.

Because of fire-damp hazards, all electrical equipment must conform to stringent regulations. Flameproof electric motors and switchgear were normally heavier and more costly and occupied more space, but recently manufacturers had made considerable improvement in motor and switchgear design. Illumination engineers had not been able to produce artificial light of considerable intensity except by using electricity and all modern illumination was electrical. The use of electric lighting from the main supply was subject to restrictive rules, however, which precluded its general use at the coal face, and power loaders often operated under adverse lighting conditions. The more mobile American loaders were often fitted with headlamps, for in American mines the electricity rules were not so restrictive.

The authors said that the design of power loaders had been given a welcome impetus by the introduction of the armoured flexible conveyor. Machines could now be designed to take narrow webs of coal, which opened up the field to continuous mining.

Future of the Association

After the announcement that he had been elected President of the British Association for 1957, Prof. P. M. S. Blackett said that he might take as the theme of his address the place of science in the world to-day. Regarding the future of the Association, he said that it was a successful organisation and the question was whether it could be made better. There must be more co-ordination of programmes, but the Section Committees had a very valuable life and much would depend on what they wanted to do. A great deal of compromise would be required.

Prof. William Wardlaw, general secretary, said he would like at least to double the Association's income, possibly with financial support from industry. The contribution which the Association made to the industrial survival of the country was considerable.

After his Press conference Prof. Blackett told the *Electrical Review* representative, that in his opinion the speed with which nuclear energy became available in this country depended "99 per cent on engineering." Mr. A. C. Hartley, in his address to the Engineering Section, had said that by 1975 nuclear energy would be providing the equivalent of 40 million tons of coal in Britain—but that this would be only 10 per cent of our requirements.

Asked whether the physicist could help to speed this supply of energy, Prof. Blackett said he thought that even if there were some dramatic advance, such as the peaceful use of thermo-nuclear power, it would probably take 20 years to provide the plant and equipment. The rate of progress, he said, was governed by the amount of capital which the country invested in nuclear power. Already the universities and industry were feeling the effects of competition from the Atomic Energy Authority for scientists and technologists.

Asked whether we could have more and earlier nuclear power if we were prepared to pay for it, he said, "Yes, but it would mean less money spent on other things. If we spent less on other building we could do it."

* * *

An exhibition arranged by the Department of Metallurgy, Sheffield University, was held in Saint George's Square concurrently with the British Association meeting. It includes displays by Sheffield companies specialising in the production of steel, titanium and other alloys for use at very high temperatures. These materials were shown in rolled, forged and cast form and as components for gas and steam turbines. Of more directly electrical importance was a new electric laboratory furnace by Johnson Matthey & Co., Ltd., which incorporates a platinum-rhodium element.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

The Minister of Fuel and Power has appointed **Mr. A. N. Todd,** A.C.A., chief accountant of the London Electricity Board, to be deputy chairman of the Board from 1st September in succession to **Mr. D. B. Irving,** B.Sc., M.I.E.E., whose appointment as chairman of the Board has already been announced.

Mr. A. N. Todd

Mr. Todd was formerly with Deloitte, Plender, Griffiths & Co., chartered accountants. Since the nationalisation of the electricity supply industry he has been assistant chief accountant, then deputy chief accountant, of the Merseyside and North Wales Electricity Board, assistant chief accountant, British Electricity Authority, and since 1954, chief accountant, London Electricity Board.

The A.E.I. Lamp & Lighting Co., Ltd., has appointed **Mr. J. B. Henderson** to the new position of regional publicity assistant for Scotland and Northern Ireland. He will be responsible for the publicity liaison in the region and be in charge of the new showroom at the company's regional headquarters at Waterloo Street, Glasgow. Mr. Henderson was previously publicity officer for Scottish Cables, Ltd., Renfrew.

The English Electric Valve Co., Ltd., announces the following appointments:—**Mr. E. Allard,** B.Sc., A.M.I.E.E., who will in future be assistant to the general manager, was with Edison Swan during the war as a valve development engineer and later engineer in charge of a " shadow " factory; in 1946 he joined Plessey and was with them as chief of physics research until 1951, when he moved to the Ministry of Supply; as engineer in charge of valve production there, he was responsible for establishing production capacity for all Services, and buying for the Army and R.A.F., as well as liaison with development concerns, until he joined the English Electric Valve Co. in September, 1955.

Mr. R. G. Roach, B.Sc., who has been appointed manager of the Valve Division, joined the company in 1951 and has worked on the design and production of large transmitting valves. Mr. Roach was formerly in the Valve Division of Standard Telephones & Cables, Ltd., whom he joined in 1937.

Mr. J. Dain, M.A., becomes chief of microwave research. A Wrangler of St. John's College, Cambridge, Mr. Dain joined the Telecommunications Research Establishment in 1942, working on pulse modulators. In 1946 he transferred to the Atomic Energy Research Establishment and took part in the development of electron synchrotrons and high power r.f. sources for linear accelerators. In 1954 he joined the English Electric Valve Co. and has been engaged on the research and design of special types of microwave tubes.

Mr. F. C. Thompson, Ph.D., A.M.I.E.E., has been appointed manager of the Radar Tube Division. Dr. Thompson, who has served the company for the past 17 years, was seconded during the war to T.R.E. where he worked on airborne radar applications.

Mr. W. E. Turk, B.Sc., A.M.I.E.E., who has recently been appointed manager of the Photoelectric Division, joined the company in 1953. After his early career with E.M.I. Research Laboratories, where he was closely associated with the design, development and production of many new photo-electric devices, including television pick-up tubes, he is now responsible for the E.E.V. Co.'s work in this latter field.

Professor P. M. S. Blackett, M.A., F.R.S., who has been elected president of the British Association for the Advancement of Science for 1957, has been Professor of Physics at the Imperial College, London, since 1953. He was born in London in 1897 and was educated at Osborne and Dartmouth Royal Naval Colleges and Cambridge University. From 1933 to 1937 he was Professor of Physics at Birkbeck College, London, and from 1937 to 1953 Langworthy Professor of Physics at Manchester University. He was a member of the advisory committee set up in 1945 to deal with atomic energy questions and he was awarded the Nobel Prize for Physics in 1948 for his work on cosmic radiations.

Following the recent retirement of Mr. H. V. Harris as chairman and managing director of Bennis Combustion, Ltd., **Mr. G. M. Mellor** has been elected chairman of the company and joint managing director with **Mr. F. Howarth.**

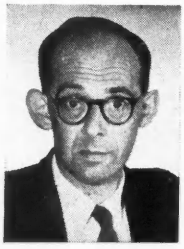
Mr. G. M. Mellor

Mr. F. Howarth

Mr. Mellor was educated at Manchester Grammar School and served with the Lancashire Fusiliers and Royal Tank Corps from 1915 to 1919, being awarded the Croix de Guerre. From 1920 to 1931 he held positions as assistant steam engineer with the Calico Printers' Association and Wollaston Gas Producers, Ltd. He then joined Edward Bennis & Co., Ltd. (now Bennis Combustion, Ltd.), as combustion engineer and later became chief combustion engineer. He was made a director in 1953 and was appointed sales director in February last.

Mr. F. Howarth served his apprenticeship with Edward Bennis & Co., Ltd., which he joined in 1914, and after experience in all departments he

Mr. E. Allard



Mr. R. G. Roach

Mr. J. Dain

Dr. F. C. Thompson

Mr. W. E. Turk

was appointed works manager in 1939, joining the board in 1944 in the capacity of works director.

Mr. W. Morgan Thompson, sales director of Monsanto Chemicals, Ltd., has been appointed a director of its subsidiary, Monsanto Plastics, Ltd.

Mr. H. B. Wood, B.Sc., A.M.I.E.E., author of the article in this issue on "Electronic Instruments," received his technical education at Woolwich Polytechnic and obtained his degree from London University. He joined Standard Telephones & Cables, Ltd., in 1942, transferring to the newly formed Standard Telecommunications Laboratories, Ltd., in 1946, where he has been engaged on electrical and electronic measurements and the application of pulse techniques.

Mr. H. B. Wood

The Midlands Electricity Board has appointed **Mr. W. M. Lawrence,** A.M.I.E.E., as manager of its Wolverhampton District, in succession to **Mr. W. F. Russell,** who recently relinquished the appointment.

Mr. Lawrence was educated at Wolverhampton Grammar School and before the establishment of the Midlands Electricity Board he held progressive posts on the staff of the West Midlands Joint Electricity Authority, with whom he received his early training at Wolverhampton power station. In 1936 he became assistant engineer in the Authority's Shropshire distribution area and from 1939 to 1948 he served as technical assistant and later as assistant transmission and distribution engineer. When the M.E.B. was formed he became divisional engineer of the Shropshire Division and, in 1949, following reorganisation, sub-area engineer of the newly formed Shropshire and Herefordshire Sub-Area. In 1955 Mr. Lawrence moved to a similar post in the Wolverhampton Sub-Area.

The **Ipswich and District Electrical Association** is holding its Ladies' Evening on 23rd November at the Royal Hotel, Clacton-on-Sea.

Mr. J. G. Shaw, who founded the Willesden Works of Lancashire Dynamo & Crypto, Ltd., sixty years ago, celebrated his eightieth birthday on 26th August; this year is also his fiftieth wedding anniversary and to mark these occasions he was presented recently with a portrait of himself in oils. The presentation was made by Mr. D. C. Lorkin, joint managing director of L.D.C. After the presentation Mr. and Mrs. Shaw and their family were entertained to lunch at which the guests included Mr. and Mrs. Lorkin, Mr. A. W. A. Dick-Cleland, Mr. and Mrs. F. H. Schroeder, and executives of the company, all of whom could look back on long years of service with L.D.C.

Mr. D. C. Lorkin (joint managing director, Lancashire Dynamo & Crypto, Ltd.), making a presentation to Mr. J. G. Shaw who is on the right with Mrs. Shaw

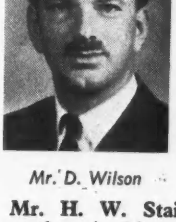
Mr. Derek du Pré has been appointed joint secretary of the Institute of Cost and Works Accountants. **Mr. Stanley J. D. Berger,** M.C., F.C.I.S., director and secretary of the Institute, continues to hold this office. Mr. du Pré has been editor of *The Accountant* since 1947 and a member of its editorial staff since 1937.

Mr. H. M. Turner, A.M.I.E.E., telephone manager, Centre Telephone Area, L.T.R., left on 1st September to become controller of telecommunications, L.T.R., at the headquarters of the London Region.

Lt.-Col. L. Bingham

Mr. Turner, who entered the Post Office Engineering Department in 1924, was appointed telephone manager of the City area in 1939. In 1950 he became telephone manager of the Centre area. He has been responsible for the telecommunications arrangements for many international conferences and State functions including the Coronation of the Queen.

Mr. Denis Wilson has been appointed commercial manager by G. Casperson, Ltd., electrical wholesalers, and their associated company, Sellers of Leeds, Ltd., as from 1st September. Mr. Wilson was formerly manager of the Leeds branch of the Stearn Electric Co., Ltd.



Mr. D. Wilson

Mr. H. W. Stainton, A.M.I.E.E., recently retired from the Metropolitan-Vickers Electrical Co., Ltd., on completion of 41 years' service with the company and 52 years in engineering. From 1925 until his retirement he was engaged on engineering sales in the M-V London office. For years an active member of the ex-British Westinghouse Committee, he was also responsible for the formation in 1950 of the London Section of the M-V Long Service Association, and was honorary secretary of the Section until his retirement.

Venner, Ltd., has appointed three new directors. **Lt.-Col. Laurence Bingham,** general sales manager, is now sales director, **Mr. Edward Tauchert,** M.I.Mech.E., C.M.B.H.I., general works manager, is now works director, and **Mr. W. H. Marsden,** A.C.A., secretary of the company, has also been appointed a director.

Mr. E. Tauchert

Mr. W. H. Marsden

Mr. C. H. A. Collyns, M.I.E.E., manager of the Fife Area of the South of Scotland Electricity Board, has been appointed manager of the Board's newly created Edinburgh and Borders Area. He will take up his new appointment on 1st October.

Mr. Collyns served in the 1914-18 war as an officer in the R.F.C. and later in the R.A.F. Returning to civilian life he took the diploma course at the Heriot-Watt College, Edinburgh, and became an Associate of the College. He then entered the service of the Musselburgh & District Electric Light & Traction Co., Ltd., transferring in 1923 to the Lothians Electric Power Co. In 1943 he was appointed general manager of both the Musselburgh & District Electric Light & Traction Co. and of the Lothians Electric Power Co. On nationalisation, Mr. Collyns was appointed the first manager of the then Fife Sub-Area of

the South East Scotland Electricity Board. He continued as manager of the Fife Area when the South East and South West Scotland Boards were amalgamated to form the South of Scotland Electricity Board. He is a past-chairman of the Scottish Centre of the Institution of Electrical Engineers and vice-president of the Fife Branch of the Association of Mining Electrical and Mechanical Engineers.

Mr. G. T. Allcock, B.Sc., A.M.I.E.E., A.M.I.C.E., manager of the former Edinburgh Area, will succeed Mr. Collyns as manager of the Fife Area. **Mr. G. F. Moore,** B.Sc., M.I.E.E., manager of the former Lothians Area, has been appointed deputy manager of the new Edinburgh and Borders Area.

Last week we reported the appointment of **Mr. O. J. Crompton,** M.Eng., M.I.E.E., and **Mr. G. H. Walton** as

Mr. O. J. Crompton

Mr. G. H. Walton

joint general managers of the British Insulated Callender's Construction Co., Ltd., as from 1st September. We now have pleasure in publishing their portraits.

OBITUARY

Mr. Cyril Alfred Ward, A.M.I.E.E., for some years an engineer in the Export Department of the English Electric Co., Ltd., died on 30th August.

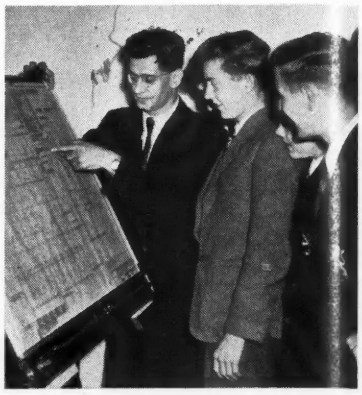
Kariba Contracts

The British Thomson-Houston Export Co. has been awarded the contract, valued at over £2,000,000, for the whole of the 330 kV switchgear for the Kariba hydro-electric scheme of the Federal Hydro-Electric Board, Federation of Rhodesia and Nyasaland, with Messrs. Merz & McLellan as consultants. The order covers complete 330 kV substations at Kariba, Kitwe, Norton, Sherwood, Salisbury and Bulawayo, incorporating twenty-three oil circuit-breakers. The 330 kV circuit-breakers included in the contract are a direct development of those installed by the B.T.H. Co. on the British 275 kV super-grid and are of the bulk oil type with lenticular tanks and include six breaks per phase, shunted by switching resistors.

An order for switchgear valued at about £36,000 has been placed by the Board with A. Reyrolle & Co., Ltd.

Grammar School Vacation Training

South Wales Switchgear, Ltd., has repeated the experiment it conducted last year in giving a week's vacation training to fourth form grammar school boys. This year the vacation apprentices numbering 75 were dealt with in three one-week courses of 25 each. The scheme last year was a big success, but greater success was obtained this year as shown by the number of fourth form boys who volunteered and gave up a week of their holiday for factory instruction and lectures. The course included a brief resumé of all the company's activities, including sales, drawing office, works, test, etc., and the instructors were specially briefed to bring work to the boys' level so that they could understand something of what an engineering career could be. The company believes that, apart from the value of the experiment in helping industry, it has important social value in giving students the opportunity of seeing a large industry before making up their minds about their future when they ultimately leave school.



Some of the students at the South Wales Switchgear course

Electrical Industries Golf Championship

The finals of the Electrical Industries National Golf Championship will be held on 1st October at the Long Ashton and Bristol and Clifton Golf Clubs, Bristol. The programme will be as follows:—

At Long Ashton (morning): Final of the E.I.N.G.C. eighteen holes medal round for the Sir Montague Hughman trophy; runner-up prize presented by Mr. J. L. Wilson; best scratch score prize presented by the late Mr. J. Y. Fletcher. The competitors for this event are the winners, runners-up and the best scratch scores in the individual area finals.

Afternoon: Eighteen holes Stableford bogey foursomes competition for the Sir Felix Pole cups, open to all competitors playing in the national final.

At the Bristol and Clifton Golf Club, Failand: All day, eighteen holes medal competition for the visitors' rose bowl presented by the Electrical Wholesalers' Federation; all day, eighteen holes Stableford bogey competition for the veterans' trophy presented by the proprietors of the *Electrical Journal.* This is open to any golfer of fifty-five years of age or over who is connected with the electrical industry. Golfers over sixty-five years of age will have one additional stroke added to their handicaps for each year over sixty-five.

The golf club charges will be 15s per day including lunch, green fee, tea and staff gratuities; 10s per day exclusive of lunch; caddies (if available) £1 per day; optional sweepstakes, 2s 6d per competition.

The dinner will be held in the Queen's Hall of the Berkeley Restaurant, Bristol (7.0 for 7.30 p.m.) where accommodation for 150 to 200 people has been reserved. Application for tickets (25s each) should be made to Mr. A. Hughes, British Insulated Callender's Cables, Ltd., 7-9, Barton Street, Bristol. The chair will be taken by Sir Henry Self. Entry forms for the golf competitions are obtainable from any area secretary or Mr. Frank Farthing, 22, Regent Hill, Western Road, Brighton 1, Sussex (telephone: Brighton 21705).

PRICES OF MATERIALS

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £197 0s 0d
COPPER, H.C. Electro	ton £305 0s 0d
Fire Refined 99·70%	ton £304 0s 0d
Fire Refined 99·50%	ton £303 0s 0d
COPPER Tubes ..	lb 2s 11½d
Sheet	ton £376 5s 0d
H.C. wire and strip ..	ton £342 10s 0d
LEAD, English ..	ton £116 5s 0d
Foreign	ton £115 0s 0d
MERCURY	flask £83 10s 0d
TIN, block (English) ..	ton £766 10s 0d
ZINC, G.O.B. Foreign	ton £95 10s 0d
Electrolytic	ton —
BRASS Tubes (solid drawn)	lb 2s 5½d
Sheet	ton £305 5s 0d
Wire	lb 3s 0½d
PHOSPHOR BRONZE Wire	lb 4s 6½d
PLATINUM	oz £34 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 27⅜d—27⅞d

VIEWS on the NEWS

By REFLECTOR

I HAVE often thought that the gas people were strongly in favour of "integration," which roughly means the allocation of duties to the gas, electricity, coal and oil industries instead of permitting them to compete with one another. Probably I have been wrong because the *Gas Journal*, commenting on a recent letter in the *Electrical Review*, shows itself to be in favour of competition. It says that, apart from efficiency and cost, "with competing industries and a choice of four fuels life is so much more interesting." In approving this sentiment I cannot be held to agree with all the *Gas Journal's* statements, particularly the one which says: —

> "Everyone must surely agree that for light and power electricity is pre-eminent, but when it comes to heat the average householder is not going to put up with what one might term a mess of wattage."

I know many people who have exchanged their gas birthright for this.

* * *

The regeneration of the Highlands through the agency of hydro-electric power still seems to be regarded as secondary to the preservation of fishing rights. The Fisheries Committee appointed to advise the Secretary for Scotland and the North of Scotland Hydro-Electric Board on such matters has expressed dissatisfaction at the operation of the Board's fish passes which it contends do not allow smolts and kelts to descend freely. An inquiry has been ordered by the Secretary for Scotland.

The effect on salmon and trout fisheries of hydro-electric schemes and other uses of rivers is to be discussed in November by the Salmon and Trout Association. According to the *Scottish Sunday Express*,

> "in recent months a feeling has been growing that the big Highland water power schemes are not panning out as favourably for the fish as had been expected."

* * *

American presidential elections, and the various stages which precede them, are conducted in a very different fashion from general elections in this country. This is largely why they are given almost as much attention here as is devoted to our own comparatively minor affairs. I have been reading in the *Electrical World* some particulars of the special electrical arrangements made for the Republican National Convention at the "Cow Palace," San Francisco. Normally this arena has a transformer capacity of 750 kVA but for the Convention it was reckoned that 1,500 kVA would be needed, divided equally between lighting, radio and television, and air conditioning (with the already-installed lighting). To guard against possible breakdowns a 100 per cent safety factor was observed, i.e. six 500 kVA 12,500/125/216 V transformers were installed. Some idea of the intensity of the lighting is given by the statement that on the platform area the illumination was raised from 40 to 200 ft-candles. The whole installation cost over $175,000 (say, £58,000); most of the cost was met by the radio and television networks, leaving the Republican Party to foot the rest of the heavy bill. I presume that most of the added plant was recovered but the article does not say so.

* * *

A survey of consumer expenditure by the United States Bureau of Labour Statistics has shown that, as might have been expected, the amount spent on electricity rises directly with income. Apart from this the pattern is rather complicated. For instance in the southern States the consumer in the lowest "income bracket" (under $1,000 a year) spends the least of all on electricity but in the same region the over $10,000 a year customer has the biggest bill. The general average seems to be highest in the northern States which also have the least difference between high-income and low-income consumers. In every region the average expenditure is lowest in the large cities and generally highest in the small cities, with suburban areas in between. The reasons for the poor showing of city residents are believed to be that gas is more readily available to them and that the large number of apartment dwellers are without the washing machines, dryers and water heaters which are widely used in other areas. The figures relate to 1950, showing that the United States is not always so prompt with its statistical information as is generally believed.

* * *

Mr. S. Goosman, the New Zealand Minister of Works, said last week that the British Government's withdrawal of its support for the Wairakei geothermal steam power station had delayed construction for two years. An agency message reporting this added the information that

> "The 69,000 kilowatt plant is designed to harness steam coming from natural bores in the Wairakei area, converting it to heavy water for the production of electricity for the North Island."

I do not think that that is quite the process originally envisaged.

* * *

Under the heading "Brush's Colossal Dynamo," the *Electrical Review* of 10th September, 1886, gave some particulars of what was then the largest generator produced by the Brush Electric Co., of Cleveland, Ohio. Although it was noted that improved design had reduced the size needed to provide the output by half, this machine was still said to be

> "14ft long, 5ft 2in high, 4ft 2in wide, and weighs in all 22,000 pounds. The weight of the copper used on the machine is 6,250 pounds. The diameter of the pulley is 40in and of its face 45in. The normal speed of the dynamo is 430 revolutions per minute."

All this size and weight was necessary to produce "300,000 watts, or the equivalent of 5,000 incandescent lamps of 16 candle-power each," which just shows how far we have come in the last seventy years.

British Food Fair

THE service provided by electricity in the preparation, packaging and preserving of foodstuffs is much in evidence at the fourth British Food Fair which is being held until 15th September at Olympia, London. On the British Electrical Development Association's stand daily cookery demonstrations are being given by Miss Marguerite Patten, the B.B.C. television cookery expert, on nine different automatic electric cookers. Food preparation by electrical methods forms the theme of further demonstrations. The wide range of electrical appliances on view includes dish washing machines, refrigerators, water heaters, hand-dryers, an electric incinerator and a pest controller in the form of an electric fumigator for dealing with the problem of flies in the kitchen. Electric fans ensure adequate ventilation and also serve to prevent cooking odours from spreading to other rooms. The importance of good lighting is not overlooked and this is demonstrated by the use of colour selected fluorescent fittings.

Electrical appliances of many kinds are to be seen on the stands of food exhibitors and there are also a number of individual manufacturers with their own displays. The Kenwood Manufacturing Co., Ltd., for example, show their versatile "Chef" food mixer in a new range of colours with variable coloured plastic fittings to match most kitchen colour schemes, the attachments including a dough hook, for housewives who prefer to bake their own bread. Sunbeam Electric demonstrate their "Mixmaster" food mixer with mix-finder dial, in addition to their heat-controlled automatic frying pan.

Of special interest on the stand of the United States Government, who incidentally are participating for the first time at the Fair, is what is claimed to be the British housewives' dream of tomorrow, the American "Kitchen of To-day." Designed by Frigidaire it incorporates a large automatic cooker with four "radiantube" hotplates, interior oven light and double doors which when opened automatically draw out the bottom oven shelf. The point for plugging-in an electric kettle, coffee pot, etc., is also time controlled, and another feature of the cooker is an automatic roasting spit. The whole kitchen, which is in a shade of "Mayfair Pink," includes also a waste food disposal unit, dish washer, washing machine and dryer and a refrigerator with a frozen food compartment opened by a pedal.

After opening the British Food Fair the Minister of Agriculture, Fisheries and Food (Mr. D. Heathcoat Amory) toured the exhibition. In the photograph Mr. D. Metcalfe, E.D.A. stand manager, is explaining to him the operation of an electric dish washer

Heat Insulation

THE British Standards Institution announces the publication of a revision of the definitions of heat insulating terms and methods of determining thermal conductivity. (B.S. 874: 1956; B.S.I. Sales Branch, 2, Park Street, W.1, price 5s.)

Part I of this Standard contains definitions of heat insulating terms and a summarised list of relevant symbols and dimensions of units. The measurement of thermal conductivity and emissivity is described in Part II, including methods used for different types of materials for various temperature ranges. Conversion tables for units in common use are provided in appendices.

One purpose of Part I is to provide means of establishing consistency in definitions of terms, particularly so that there should be as little conflict as possible with analogous terms used in other countries and with a view to rectifying confusion which may exist in the use of such words as "conduction," "conductance" and "transmission." One of the changes made is the adoption of the joule as the fundamental unit of heat in accordance with B.S. 350: 1940, Amendment No. 4, October, 1953 (P.D.1715), which also defines the corresponding values for the revised steam table British thermal unit and the revised steam table calorie. The effect of this change on heat insulation calculations is negligible.

A complete revision has been made of the methods used for measuring thermal conductivity, thermal conductance and thermal transmittance of heat insulating materials and structures. Since properties of materials, including thermal conductivity, may change during the working life, provision is not made in this Standard for general requirements for thermal insulating materials; for these, reference should be made to other British Standards according to the type and use of the product.

Electric Locomotive Modifications

THE Eastern Region of British Railways is to modify the electric locomotives operating on the Manchester-Sheffield-Wath electrified line. The modifications include an improved dynamic braking system for the 58 Bo+Bo locomotives, complementary to the existing system, h.v. cab heaters for the 58 Bo+Bo and 7 Co−Co locomotives in use on the line and air operated windscreen wipers for 64 of the locomotives.

All the electric locomotives on the line are at present fitted with regenerative braking. This cannot be used to reduce speed below about 16 m.p.h. The equipment with which the Bo+Bo locomotives are to be fitted will provide rheostatic braking by means of which, when it is required to stop a train or reduce its speed below about 16 m.p.h. (when the system of regenerative braking becomes ineffective), connections can be altered to disconnect the motors from the overhead contact wire and connect them to the locomotive starting resistances. By this means the speed can be reduced to something like 3 m.p.h.

The present cab heating has proved to be insufficient, particularly on the exposed section of line over the Pennines, but the needs are also influenced by different circumstances under which electric locomotives operate relative to steam. The amount of electricity available for low-voltage heating has been limited by the capacity of the 5 kW motor generators which also have to provide current for controls, lighting, etc. A throw-over switch was provided to limit heating to one cab per locomotive at a time, but this has not given satisfactory driving conditions where the length of run in either direction is relatively short. To reduce the load on the m.g. sets and to improve the cab heating on the locomotives l.v. heaters are being removed and h.v. heaters of greater wattage fitted to each of the 65 locomotives. At the same time 64 of the locomotives are to be fitted with 128 air-operated windscreen wipers replacing hand-operated wipers.

The contracts for this equipment have been placed with the Metropolitan-Vickers Electrical Co., Ltd., who were the main contractors for the supply of the electrical equipment when the locomotives were built.

Aircraft Electrical Equipment

Notes on the Farnborough Exhibition

MANY new or improved electrical items are as usual to be found at the exhibition of the Society of British Aircraft Constructors, which is being held this week (3rd to 9th September) in conjunction with the flying display at the Royal Aircraft Establishment at Farnborough, Hants. Tendencies continue to be towards compactness and light weight and an increased operating temperature range, with quicker response to controls in appropriate instances. The principles adopted in many of the designs suggest that these could be extended to industrial applications.

Among the examples of larger plant is a constant-speed "Sundstrand" drive for a 40 kVA 400 c/s alternator by the English Electric Co., Ltd. The control panel for the alternator has not been exhibited previously. The same company shows, also for the first time, a 12 kW starter-generator (10 h.p. as motor), a 28 kVA alternator, a transformer rectifier unit to give 28 V d.c. and three actuators; one of the last named, of the rotary type, has a normal working load of 20 lb-in and an operating time for 90 deg of 0·2 sec. The selection of a.c. and d.c. motors includes one of only 1in diameter.

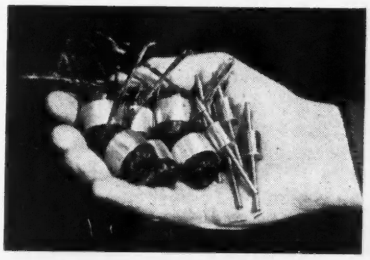
Very small induction motors, as used for radar servo-control, are a feature of the range of a.c. and d.c. motors displayed by the British Thomson-Houston Co., Ltd., which also has on view ignition units supplied at 24 V d.c. for gas turbines. Auto Diesels, Ltd., are exhibiting the new "no-break" alternator equipment, which has been ordered by Cable & Wireless, Ltd., and is similar to the recent 40 kVA three-phase and 6·25 kVA installations at London Airport for securing continuity of supply in the event of a breakdown in the public electricity supply mains.

Passenger comfort and airport lighting provide the main themes of the equipment demonstrated by the General Electric Co., Ltd. The first is represented by a galley fitted with catering equipment, which includes a novel type of coffee maker, and by a three-way reading light adjustable to suit variable seating arrangements. In the second category is a new runway angle-of-approach indicator by flashing coloured beams projected at different inclinations.

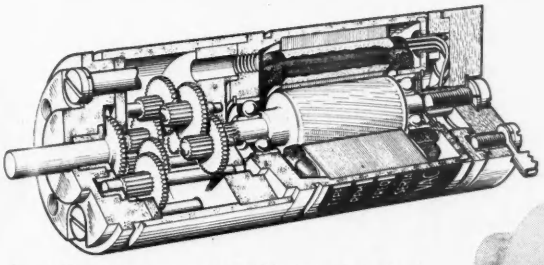
The Westinghouse Brake & Signal Co., Ltd., gives prominence to various types of compact rectifiers, such as the aluminium "Westalite" without cooling fins for operating in ambient temperatures up to 85 deg C and a contact-cooled unit for chassis mounting. Copper-oxide rectifiers and germanium diodes are also included. Several types of transportable "Westruk" units providing power for ground servicing and starting are on view on a second stand. Gloster Aircraft have taken the occasion to inaugurate a technical development division with the duty of extending the aircraft company's activities into general industry and the home, several examples of which are provided.

Vactric (Control Equipment), Ltd., is showing servo-motors, servo-gearheads, tacho-generators and motor-generators, radar sets, analogue computers and electronic equipment. Included in a wide range of established aircraft-wiring cables, displayed by British Insulated Callender's Cables, Ltd., is a new fire-resisting cable, "Unifire F." This is designed to operate for five minutes at 1,100 deg C and to have good fuel, oil and moisture resistance. A similarly comprehensive range has been brought together by W. T. Henley's Telegraph Works Co., Ltd., whose new developments include p.v.c. insulated types and a cable for use at high temperatures. Among other items are a coil-end flexible for withstanding high temperatures and solvents used in impregnation and solder-coated copper wire used in printed circuitry.

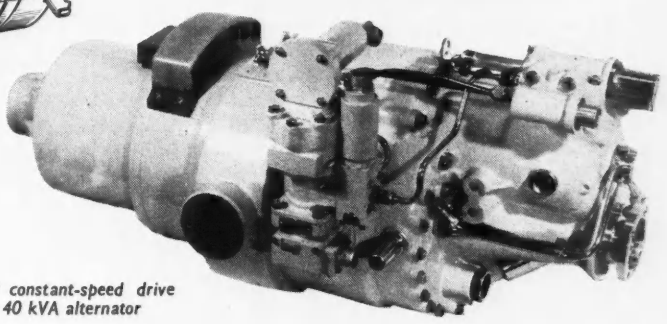
Among the wiring accessories shown by the Plessey Co., Ltd., is a pressurised plug and socket for use at up to 400 deg C, the inserts of which are brazed directly into the ceramic insulation. A new crimping termination eliminates the need for cable stripping inside a lug. For providing precise transmission of data when applied to instrument and computing systems a demonstration of synchros is staged. Components required for electronics and telecommunications are fully exemplified. There is also a



Miniature B.T.H. induction motors

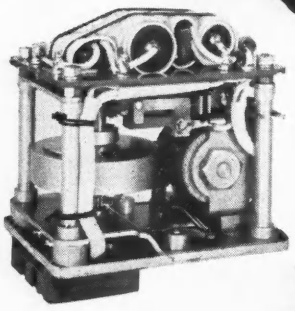


Above: Two-phase servo-motor (400 c/s) and gearhead with reduction of 850:1 made by Vactric (Control Equipment), Ltd. Inertia of motor 1 gm-cm² and with gearhead coupled 1·1 gm-cm²



Right: View of "Sundstrand" constant-speed drive coupled to English Electric 40 kVA alternator

Ferranti seven-range clip-on voltammeter for 400 c/s



Left: Plessey inertia flasher unit for controlling aircraft navigation lights

Right: Venner silver-zinc accumulators for emergency supplies on aircraft

flasher unit which employs inertia timing for controlling aircraft navigation lights.

Aircraft fuses and fuseholders and electronic components form the basis of the exhibit of Belling & Lee, Ltd. A notable example is a light-weight busbar-mounted 30 V airfuse in ratings of from 35 to 500 A. Printed-circuit connectors and varied assemblies of screened connectors are also on view.

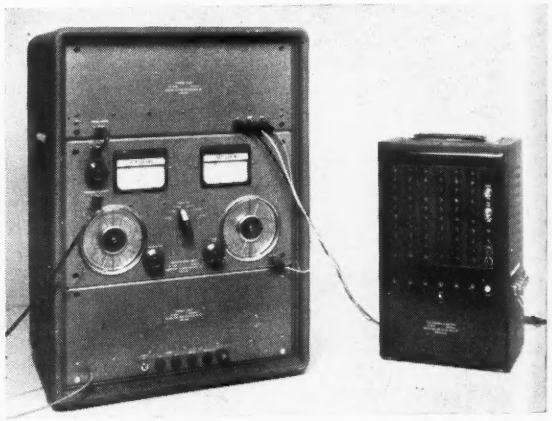
A recent addition to the "Exide" family shown by Chloride Batteries, Ltd., is one rated at 25 Ah 24 V, the cells of which are assembled in moulded boxes of high-impact polystyrene, a material immune to both acid attack and the effects of temperature extremes. An improved design of the Dagenite 12 V 40 Ah battery that makes considerable use of polystyrene and is 12 lb lighter than the original model, is displayed by Peto & Radford, Ltd., whose exhibit also includes a model which is ventilated to the atmosphere outside the aircraft. Silver-zinc reaction accumulators, as used for emergency supplies, which are claimed to save five-sixths in weight and four-fifths in size of conventional accumulators are to be seen on one of the two Venner stands. On the other are mounted instruments for different control systems, synchronous-motor-driven code senders and several electronic instruments.

Soft magnetic alloys are assembled on the stand of the Telegraph Construction & Maintenance Co., Ltd. These include "Super-Mumetal," which has an initial permeability of 200,000, and special "Radiometal" with corresponding values of 4,500 and 45,000. The former is suitable for high-gain magnetic amplifiers and the latter for sensitive fuel-control solenoids. An improved iron-cobalt-vanadium "Permadur" alloy is intended for light-weight generators. The recently introduced Telcon airfield lighting cable and the established helical membrane cable for radar and v.h.f. equipment are also shown.

In addition to plastics, especially its polytetrafluoroethylene product, Fluon and Durvic rigid p.v.c., Imperial Chemical Industries displays a range of wrought non-ferrous materials and a new "Marlite" tank weighing only 1·4 oz/sq ft and made by its subsidiary Marston Excelsior, Ltd. The central feature of the stand of Bakelite, Ltd., is a group of polyester resin-glass fibre components which combine light weight with strength.

Exhibits by Ferranti, Ltd., include gunsights and gyroscopes with their special electrical features, measuring instruments, the medium-sized electronic digital "Pegasus" fast computer, a high-speed tape reader and a high-power "Klystron" oscillator (500 W and 15 per cent efficiency). Among the measuring instruments are 2, 2½ and 3½in hermetically sealed 400 c/s types for severe tropical conditions and a 7-range clip-on voltammeter with all ranges self-contained.

Seven divisions of Elliott Bros. (London), Ltd., are represented at the show. That concerned with electrical measuring instruments is presenting: a general purpose d.c. instrument for use in most ammeter, voltmeter and ratiometer aircraft applications; a high-precision polarised Bristol's synchroverter switch (weighing under 2 oz) which provides break-before-make action in synchronism with the driving current wave from 0 to 2,000 c/s; and a hermetically sealed miniature moving-coil relay for industrial electrical and electronic control circuits. Another division is also responsible for the development of servomotors in co-operation with the Royal Aircraft Establishment. A 250 VA three-phase alternator driven by a hot-air turbine is designed to give an independent 115 V 400 c/s supply



Carrier frequency meter and electronic counter (Marconi Instruments)

Marconi's Wireless Telegraph Co. micro-wave radar-link mobile receiver at Farnborough

for essential flight instruments; the unit weighs 5·5 lb.

Cockpit lighting forms a main feature of the exhibit of Thorn Electrical Industries, Ltd., in which "Plasteck" and "Pillar" console and instrument panels are displayed with lighting by Atlas lamps. Electro-luminescent signs, in which a thin layer of phosphor, sandwiched between two conducting surfaces, is excited into luminescence is another novel feature.

The principal feature on the stand of Salford Electrical Instruments, Ltd., is a precision radio altimeter which works by means of signals radiated continuously by a v.h.f oscillator which sweeps at a known speed through a band of 50 Mc/s. Power is fed through a G.E.C. battery superseder giving a stabilised 24 V output. The Solartron Electronic Group, Ltd., shows for the first time its servo-test console, which consists of transfer function analyser, mechanical reference generator, carrier convertor and subsonic power amplifier.

Working exhibits are displayed by Decca Radar, Ltd., in association with a selection of equipment based on this company's fixed-coil viewing unit. Electronic equipment of Pye, Ltd., includes a new 1 kW v.h.f. transmitter, the "Transhailer," for ground-to-air communication.

Standard Telephones & Cables, Ltd., show a new form of precision approach radar equipment indicating the elevation, azimuth and range of an approaching aircraft relevant to the touchdown point on the runway. Compared with the firm's earlier P.A.R. equipment, the number of valves has been reduced by four-fifths, and remote control and presentation is over a single cable. New miniature selenium and silicon rectifiers are also displayed together with cathodic protection equipment. Germanium rectifiers, interference suppressors, electrolytic capacitors with tantalum electrodes, thermistors and quartz crystals figure among numerous other standard exhibits.

Marconi's Wireless Telegraph Co., Ltd., the Canadian Marconi Co., Amalgamated Wireless (Australasia), Ltd., and Marconi Instruments, Ltd , occupy four stands. The working of a new microwave radar link equipped with repeaters using travelling-wave tubes was demonstrated by the transmission of information and television pictures from London Airport to Farnborough. Without the radio link the radar display and operations centre would have to be near the scanning equipment. A newcomer to the range of airborne v.h.f. radio equipment is the AD.305 which provides for transmission over any one of 480 channels, 360 of them in the civil aeronautical range of 118 to 136 Mc/s; minimum output power is 30 W.

A selection from its wide range of electronic test equipment including new models is displayed by Marconi Instruments, Ltd. These include new counter-timers, a.c. mains-operated units for counting up to or more than million per second periodic or random pulses or for measuring time intervals up to one second in microsecond steps. Another, a newcomer to the exhibition, is a carrier deviation direct-reading meter covering the carrier frequency range 4 to 270 Mc/s which can be extended to 500 Mc/s with increased inputs.

Radio telemeters as an aid to missile testing and measuring appliances for design and servicing of airborne radar and communications systems are the principal features on the stand of E.M.I. Electronics, Ltd. E. K. Cole, Ltd., show v.h.f. communication apparatus for ground and airborne use, including a new transmitter and control equipment and direction finders for two-channel ground-to-air radio telephones.

The main exhibit by Ekco Electronics, Ltd., is an airborne search radar system, but for more general use there is shown a control device for fitting to existing machine tools requiring precision control in the production of machined parts in small quantities. Mullard, Ltd., is demonstrating its electronic radar trainer system and ferrite microwave isolators (1 W and 50 W), which enable energy to be propagated down a waveguide in one direction with low losses and in the other with considerable attenuation.

Redifon, Ltd., is displaying examples of its radiocommunications equipment and the Graviner Manufacturing Co., Ltd., has on view various airborne electrical devices for securing protection against fire and explosion hazards.

Cross-Channel Cable Project

Joint Committee Recommends Adoption of D.C. Transmission

THE Central Electricity Authority and Electricité de France have now received from the joint committee set up to consider a cross-Channel connection between the electricity networks of this country and France a recommendation to adopt direct current by means of a single cable capable of transmitting between 120 and 150 MW at 200 kV. Work is expected to begin early next year and to be completed at a cost of about £4 million in 1960.

A preliminary project for interconnection of the British and French electricity systems by means of submarine cables across the Channel was studied during the latter years of the war, but technical possibilities at the time did not justify a project on a scale which would yield any economic advantage and the scheme was abandoned. Study of the problem was again taken up in 1951, the technical possibilities of interconnection having in the meantime become more favourable as a result mainly of progress in the manufacture of high-voltage cables.

The study then started was eventually concentrated on transmission of the order of 150 MW at 132 kV by four three-phase a.c. cables, one being in reserve. Preliminary tests were undertaken in 1953 on various types of cables and their accessories, in addition to experimental laying of lengths of cable and undertaking repairs at sea, which have been reported in the *Electrical Review*. The tests resulted in agreement between the C.E.A. and E.D.F. towards the end of 1955, on the use of gas-filled, single-core, pre-impregnated paper-insulated cables.

At the end of 1955, the success of the 100 kV d.c. interconnection installed between Sweden and the island of Gotland, and progress in the development of high-power mercury-vapour mutators indicated the early possibility of transmitting 150 MW at 200 kV by a single cable.

Taking into account the special risks due to navigation and fishing, which are likely to cause the greater proportion of faults in submarine cables in the Channel, the availability of the connection by a single d.c. cable would be comparable with that of an a.c. connection using four single-core cables. In addition to the resulting economy, this would obviate laying a multiplicity of cables between here and France.

Important advantages of the d.c. connection are that it will allow the two interconnected systems to control their frequencies quite independently and to regulate agreed load interchanges with greater precision.

American Aid for Brazil

FROM OUR RIO CORRESPONDENT

A JOINT communiqué by the presidents of the Export-Import Bank and the Brazilian Bank for Economic Development implies that financial assistance to carry out President Kubitscheck's development plans will depend on the adoption by Brazil of efficient measures to control inflation and place finances on a stable basis.

The Washington Bank has agreed in principle to finance exports of capital goods for the development, by the Government or private initiative, of electric power supplies, transport services, industry and agriculture. Also, to the adoption of an automatic process for extending the period for repayment of short-term commitments and, if necessary, to a five-year extension for the amortisation of long-term loans, in order to maintain essential imports from the United States. For some months past American business circles have been pressing the Bank for some such measures to check the drift of Latin-American trade to Europe and Japan.

Transport and Power

As a preliminary step in the financing programme, the Bank has opened a credit of U.S.$151·4 million to be applied as follows: $100 million to re-equip Federal and State railways, including electrification of certain sections, expenditure to be controlled by Rede Ferroviaria Federal S.A. (according to a project before the Brazilian Congress, these railroads are to be converted into joint stock companies, with Rede Ferroviaria as the co-ordinating body); $25 million is set aside for port works, to be expended under the direction of a special autonomous agency, to be created for the purpose of supervising the operation of Brazil's ports; and $26·4 million is allotted for the production of electric power.

Of the last-named sum $15 million is earmarked for American equipment to raise the capacity of the Paulo Afonso hydro-electric plant from 180 to 240 MW. The balance will be used to expand capacity of the Camargos and Itutinga hydro-electric stations. These were built in 1952 for the Centrais Electricas de Minas Gerais, to supply power to local distributing companies, official and private. The credit will finance the installation of two additional 20,000 h.p. units at Itutinga and two of 36,000 h.p. at Camargos, as well as the purchase of materials to extend transmission lines to other areas of Minas Gerais. The turbines have been ordered from S. N. Smith, New York, and the generators for Itutinga and Camargos from Westinghouse Electric and International General Electric. The plant should be in operation in thirty months.

The communiqué describes President Kubitscheck's plan to raise installed capacity from 3,000 to 5,000 MW by 1960 and to put work in hand for an increase to 8,000 MW by 1965. In addition to the expansion programme of Empresas Electricas Brasileiras and the Tres Marias dam, mentioned in the *Electrical Review* of 13th July last, the plan includes a hydro-electric station at Furnas and several projects by mixed-economy societies in the States. The cost of imports to 1960 is estimated at $300 million and for subsequent work at $100 million. The Export-Import Bank agrees that expansion of generating capacity is vital for Brazil's economic development and confirms a credit of $120 million for Empresas Electricas' expansion programme, but is not prepared to assume further commitments at present.

The Sao Paulo Government's ten-year emergency plan, referred to in the *Electrical Review* of 6th April last, does not depend on American aid. Installed capacity is to be raised from 1,100 to 1,570 MW by 1957, overcoming the present power shortage. The Light & Power's Cubatao underground station will contribute 390 MW and Cia. Paulista's Peixoto plant 80 MW. The plan provides for a further increase of 1,857 MW in ten years. Six hydro-electric stations will be built in the Capital and Paraiba Valley area, with a combined capacity of 633 MW; four in the Central zone, with 490 MW; and eight described as independent systems, with 733 MW.

Sao Paulo has signed a contract with the Cia. Hydro-electrica do Rio Pardo to build a 160,000 h.p. station at Barra Bonito, on the Rio Tiete. The cost is estimated at 1,200 million cruzeiros (say, £6,000,000 at the present free rate), including 400 million for equipment. Three other stations will be built later on the Tiete.

Rio Grande do Sul has obtained a Federal loan of 120 million cruzeiros to complete the thermal-electric station at Candiota, in the neighbourhood of the San Jeronimo coal mines. This is the first of a series of plants to be built in mining areas under the National Coal Plan to operate on local coal. Candiota will supply power for the electrification of the State railway and regional industries.

Two other State Governments have taken steps to increase installed capacity. The Governor of Piaui has appointed a committee to investigate the hydro-electric potential of the Poty River basin. This State, with an area of 96,236 sq miles and a population of 1,064,000, has only 8,666 kW installed capacity, all thermal. The Parana Government has organised a mixed-economy society, with an initial capital of one million cruzeiros, to build a power station on the Naturi River, an affluent of the Parana, and exploit progressively the water power of the Salto de Guaira, a chain of seven great cataracts on the Parana River.

Industrial Developments

Three Sao Paulo firms, A. Grassi, Elevadores Atlas and Cia. Paulista de Material Electrica, have formed a combine under the title of Troleibus S.A. and have completed arrangements with Marmon-Harrington, of Indianopolis, Westinghouse Electrical International and Ohio Brass Company to build and install electric trolley-buses in Brazil. An initial output of 20 vehicles monthly is planned, delivery to start within twelve months. Axles, brakes, air compressors and certain other accessories will be imported for the present.

The Rio Municipality has invited tenders, to be submitted by 8th October, for the provision of electric buses in the Federal District; 110,000 metres of overhead wires and 200 buses, with all-metal chassis, three doors and pneumatic control, will be required at the outset.

The Rio State Government is to expand the Niteroi service of trolley-buses within the next two years. The system will be extended to other districts.

The following have been registered as "*national similars*," namely, as equal in all respects to their imported counterparts and produced in adequate quantities to supply market needs:—Static transformers of up to 10,000 kVA and 88 kV, built in Brazil by General Electric S.A.; and valves and electrodes manufactured by Standard Electric S.A. Seven plants in Sao Paulo and two in Rio have now a combined annual output of 30,000 television sets. The following new enterprises are starting production:—Metropolitan Overseas Supplies, electronic tubes; Nicolas Ligete, electric wires and cables; Siemens do Brasil, transformers and electric meters.

Electronic Instruments

Applications of Negative Feedback

By H. B. WOOD, B.Sc., A.M.I.E.E.*

NOWADAYS electronic instruments are used for the measurement of a great variety of physical quantities in almost every branch of science and engineering. All such instruments, however, have one basic principle in common; that is to employ some form of transducer in order to generate an e.m.f. which has some fixed relationship to the parameter to be measured, and to use this e.m.f. to operate a measuring device.

As the e.m.f. produced in this way is generally very small, it is necessary in most cases to employ electronic amplifiers in order to obtain a sufficiently high level to produce a reasonable deflection on an indicating instrument such as a meter or a cathode ray oscilloscope, etc.

Now it is well known that the gain of an electronic amplifier depends upon the characteristics of the valves and the various electrode potentials. Consequently if the characteristics of the valves in an amplifier circuit change due to ageing, or if the potentials applied to the electrodes change due to mains supply voltage fluctuations, then the parameters of the amplifier will also change. In general an amplifier which is sensitive to such variations is of little value in a measuring circuit, as the calibration of the circuit would be unreliable and would require frequent checking. Fortunately the use of negative feedback can largely alleviate these difficulties and enable the production of highly stable circuits.

In addition to improving the stability of the characteristics of normal "flat" amplifiers, however, negative feedback can be employed to produce a wide variety of other useful characteristics such as selective frequency response and amplitude-time response, i.e. waveform shaping, etc. Irrespective of the characteristics required from a feedback amplifier, the basic principles outlined in the next section must always apply.

Basic Theory

Fig. 1 is the schematic diagram of a feedback amplifier comprising an amplifier section and a feedback network. The amplifier section has a voltage gain of $-A/\theta$ whilst the feedback network which is normally passive has a voltage gain of $+\beta/\alpha$ (β is generally <1). The phase angles θ and α are principal values, i.e. $-\pi<\frac{\theta}{\alpha}<\pi$.

If we consider a voltage V applied to the input terminals of the amplifier section, then a voltage $Vo = -VA/\theta$ will appear at the output of the system. This voltage is applied to the input of the feedback network and results in an output voltage $V_1 = -VA\beta/\theta+\alpha$ as shown in the diagram. The input voltage to the whole system Vin required to maintain the output voltage Vo is evidently the difference of V and V_1, i.e. $Vin = V-V_1$. Therefore the overall gain of the complete system is:

$$-A^1/\gamma = \frac{Vo}{Vin} = \frac{-A/\theta}{1+A\beta/\theta+\alpha}$$

whence

$$A^1 = \frac{A}{1+A\beta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

and the phase shift of the complete system

$$\gamma = \tan^{-1}\frac{\frac{\sin\theta}{(A\beta)}-\sin\alpha}{\frac{\cos\theta}{(A\beta)}+\cos\alpha} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The denominator in equation (1), $1+A\beta$, is generally called the feedback factor of the system, and expresses the ratio of the gain without feedback to gain with feedback. This ratio is frequently expressed in decibels, e.g. an amplifier having 20 dB of negative feedback has its voltage gain reduced by a factor of 10. It is important to note that if the feedback factor is very large, then $1+A\beta \simeq A\beta$ and consequently equation (1) and (2) reduce to:

$$A^1 = \frac{1}{\beta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\text{and } \gamma = -\alpha \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Thus for large values of feedback factor, the overall gain of the system is $-\frac{1}{\beta}/\alpha$; that is the modulus of the gain is the inverse of that of the feedback network, and the phase shift is minus the phase shift of the feedback network. Both of these quantities are obviously independent of the characteristics of the amplifier section. The implication of equations (3) and (4) is that when large values of feedback factor are employed, there is a "virtual earth" at the input terminals of the amplifier section. That is, the input terminals of the amplifier section appear to be at the same potential, and consequently the input voltage to the complete system is required only to oppose the output from the feedback network.

Now in order to give equation (3) an accuracy of 1 per cent, $1+A\beta>100$. In general, feedback factors of this magnitude are difficult to realise because of the very stringent requirements placed on the phase shift in the system if instability is to be avoided. To ensure stability, the overall gain of the system must be less than unity at any frequency at which the total phase shift around the circuit is a multiple of 2π radians. Thus, in the case of high gain amplifiers involving several stages, the

* Standard Telecommunication Laboratories, Ltd.

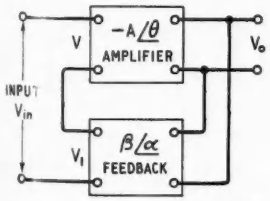


Fig. 1

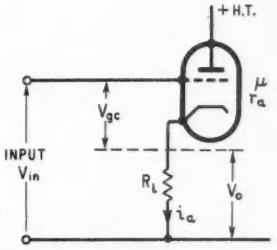


Fig. 2

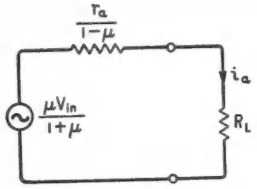


Fig. 3

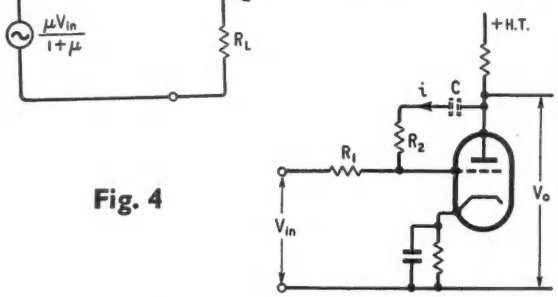


Fig. 4

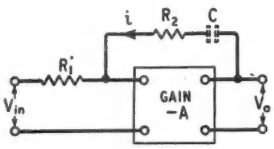


Fig. 5

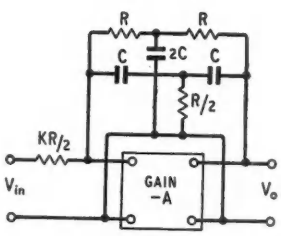


Fig. 6

permissible phase shift per stage is small, and this greatly increases the difficulties of design.

It is seldom necessary, however, to employ the very large values of feedback factor required to satisfy equations (3) and (4). For many purposes it is sufficient to make the overall gain of a system constant and substantially independent of changes in the amplifier section; the precise value of gain being relatively unimportant. This condition can be achieved with comparatively small values of feedback factor.

Thus from equation (1):

$$\frac{dA^1}{dA} = \frac{1}{(1+\beta A)^2} = \left(\frac{A^1}{A}\right)^2$$

and a change in amplifier gain δA would produce a change in overall gain of

$$\delta A^1 = \frac{dA^1}{dA}.\ \delta A = \left[\frac{A^1}{A}\right]^2 \delta A$$

$$\text{or } \frac{\delta A^1}{A^1} = \frac{A^1}{A^2}.\ \delta A \text{ per cent} \quad \ldots\ldots\ldots\ldots (5)$$

It is instructive to apply these results to a particular case. Consider an amplifier having an intrinsic voltage gain A=100 and a feedback network for which β=0·09. Then the overall gain of the system is given by equation (1)

$$A^1 = \frac{100}{1+100\times 0{\cdot}09} = 10$$

Equation (3) would give $A^1 \simeq \frac{1}{\beta} = \frac{1}{0{\cdot}09} = 11{\cdot}1$ and this result is in error by approximately 11 per cent. From equation (5), however, we see that if the amplifier gain A changes by 20 per cent (due to valve ageing, etc.), the overall system gain would change by only 2 per cent.

This shows quite clearly that the system gain is substantially independent of changes in the amplifier section for values of feedback factor which are insufficient to make equation (3) a good approximation.

Examples of Feedback Circuits

In order to illustrate some of the diverse characteristics which can be obtained from negative feedback amplifiers a few of the commonly encountered circuits will be discussed.

(a) *The cathode follower*

This circuit, which is the most simple form of negative feedback amplifier, is frequently used to isolate two circuits and reduce loading effects. One variation of the circuit is shown in Fig. 2.

From the diagram, $V_{in} = V_{gc} + V_o$ .....(6)

and $V_o = i_a R_L$

$$\text{Now } i_a = \frac{\mu V_{gc}}{r_a + R_L} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

where μ and r_a are the amplification factor and anode impedance of the valve respectively.
Rearranging equation (7) gives:

$$V_{gc} = i_a \left(\frac{r_a + R_L}{\mu}\right) = i_a.\ \frac{r_a}{\mu} + \frac{V_o}{\mu}$$

and substituting this result into equation (6) and rearranging

$$V_o \left(1 + \frac{1}{\mu}\right) = V_{in} - i_a.\ \frac{r_a}{\mu} \quad \ldots\ldots\ldots\ldots (8)$$

This result indicates that the cathode follower has an equivalent circuit which may be represented as in Fig. 3 by a voltage generator of magnitude $V_{in}\left(\frac{\mu}{1+\mu}\right)$ volts and internal impedance $Z_o = \frac{r_a}{1+\mu}$ ohms.

Substituting for i_a in equation (8) we obtain an expression for the voltage gain of the system, i.e.:

$$A = \frac{V_o}{V_{in}} = \frac{\mu R_L}{R_L(1+\mu) + r_a}$$

and if $\mu >> 1$

$$Z_o \simeq \frac{1}{gm} \text{ and } A \simeq 1 \text{ where } gm = \frac{\mu}{r_a} \text{ is the mutual}$$

conductance of the valve. The condition $\mu >> 1$ is that required for the formation of a virtual earth between the grid and cathode of the valve, and consequently the input impedance of the device is simply the reactance of the grid anode capacitance of the valve.

(b) *The anode follower*

The anode follower may comprise a single valve circuit Fig. 4 or a multi-stage amplifier Fig. 5, each having feedback resistors R_1 and R_2. The capacitor C shown dotted in the diagrams may be used for a.c. coupled feedback, and should have a low reactance at the lowest frequency to be amplified. If a virtual earth is assumed to exist at the input terminals of the amplifier, then the output voltage V_o will drive a current $i = V_o/R_2$ through the feedback circuit. Now, as the input impedance of the amplifier may be assumed infinite at low frequencies, no current can be diverted through the input terminals of the amplifier, and, hence, by Kirchhoff's second law, the current in R_1 must also be i. The current i in R_1 produces a voltage drop across $R_1 = iR_1 = \frac{V_o}{R_2} R_1$ and this must be equal and opposite to the input voltage to the

system, i.e. $\text{Vin} = \frac{-\text{Vo}}{R_2} \cdot R_1$. The voltage gain of the system is therefore

$$\frac{\text{Vo}}{\text{Vin}} = \frac{-R_2}{R_1}$$

The overall phase shift of the circuit would be zero at low frequencies, and would in general increase at high frequencies due to stray capacitance across the feedback resistors R_1 and R_2. It should be noted that with this type of connection, the current i flows through the signal source; consequently the input impedance of the system is given by $\text{Vin}/i = R_1$. A further point to note is that if $R_1 = R_2$, the gain is -1; therefore the anode follower and cathode follower circuits are complementary.

(c) *Selective feedback*

An important type of negative feedback circuit is that which provides a selective frequency response. This is particularly useful at low frequencies, where it becomes increasingly difficult to construct inductors having the sufficiently high Q values required for the more conventional selective amplifiers employing tuned circuits.

A typical circuit employing a twin-T feedback network is shown in Fig. 6. In order to analyse the circuit, it is useful to replace the twin-T with a single π network, Fig. 7, using the T to π transformation. It is seen from the diagram that the series arm of the π assumes an infinite impedance when $\omega = 1/CR$, and consequently there is no feedback at this angular frequency, which we will denote by ω_0. The overall gain of the system may then be written:

$$A^1 = \frac{4A}{k}\sqrt{\frac{1+(\omega/\omega_0)^2}{(A+1)^2[1-(\omega/\omega_0)^2]^2+16(\omega/\omega_0)^2}} \quad \ldots(9)$$

and when $\omega = \omega_0$: $A^1_0 = \frac{\sqrt{2}A}{k}$

Now the selectivity of a circuit is conveniently expressed by the figure of merit $Q = \frac{f_0}{\Delta f}$ where fo is the resonant frequency and Δf is the bandwidth between the -3 dB (70·7 per cent) points on the response curve. Applying this criterion to the present case, we must calculate Δf, the difference between the frequencies at which the gain is $\frac{A^1_0}{\sqrt{2}}$.

Thus from equation (9)

$$\sqrt{\frac{1+(\omega/\omega_0)^2}{(A+1)^2[1-(\omega/\omega_0)^2]^2+16(\omega/\omega_0)^2}} = \tfrac{1}{4}$$

A little rearrangement gives:

$$\omega_1 = \omega_0\sqrt{\frac{A-3}{A+1}} \text{ and } \omega_2 = \omega_0\sqrt{\frac{A+5}{A+1}}$$

or

$$\omega_2 - \omega_1 = \omega_0\left[\frac{\sqrt{A+5}-\sqrt{A-3}}{\sqrt{A+1}}\right]$$

Expanding the terms on the right hand side of this equation by the Binomial theorem yields:

$$Q = \frac{\omega_0}{\omega_2 - \omega_1} = \frac{2A+1}{8} \simeq A/4$$

Thus an amplifier having a gain of 100 and a feedback circuit designed for fo = 100 c/s would have a bandwidth between the -3 dB points of 4 c/s. The response curve is plotted in Fig. 8.

(d) *Waveform shaping*

A common example of a feedback circuit used for waveform shaping is the Miller integrator, Fig. 9. Here the feedback components comprise the resistor R and capacitor C. If we assume a virtual earth at the input terminals of the amplifier and an output voltage Vo; then $\text{Vo} = \frac{1}{C}\int i\,dt$ and $\text{Vin} = -Ri$. Hence

$$\text{Vo} = -\frac{1}{RC}\int \text{Vin}\,dt \quad \ldots(10)$$

In many applications Vin is a step function, Fig. (10a), and the corresponding output voltage is $\text{Vo} = -\frac{\text{Vin}}{CR}\cdot t + K$, which is a linear function of time, Fig. (10b).

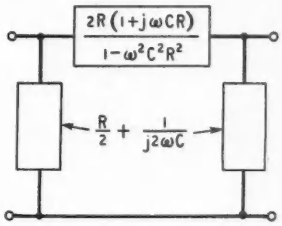
Instruments Employing Negative Feedback

In the previous sections we have discussed some of the common methods of applying negative feedback, and also indicated the general methods of analysing the behaviour of feedback circuits. The remainder of the article deals with the application of negative feedback to a few commonly encountered instruments. Circuit diagrams have not been included as there are many commercial designs available.

(a) *Stabilised H.T. power supplies*

The stabilised power supply is a circuit designed to provide h.t. current for an electronic device at a constant voltage. Thus the output voltage should remain at a fixed value irrespective of changes in mains input voltage and load current. Units designed for general laboratory

Fig. 7



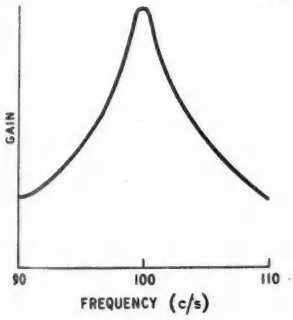
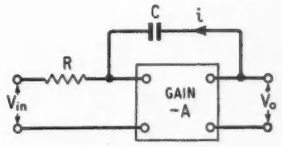


Fig. 8

Fig. 9



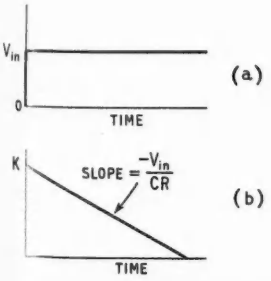


Fig. 10

use generally include provision for setting the output voltage to any desired value within the range 100–350 V.

The circuit arrangement is shown in Fig. 11, from which it is seen that a fraction n of the output voltage is compared with a reference potential Vr, which is generally derived from a neon tube, and the difference in potential δV is fed into an amplifier of gain $-A$. The amplified output is connected in series with the d.c. input from the rectifier Vin and the stabilised voltage output terminals of the unit.

Hence $Vo = kVin - A\delta V$

where k is a constant and $\delta V = nVo - Vr$

Rearranging gives:

$$Vo = \frac{kVin + AVr}{1 + An} \quad \ldots\ldots\ldots\ldots\ldots(11)$$

$$\text{and } \frac{dVo}{dVin} = \frac{k}{1 + An} \quad \ldots\ldots\ldots\ldots\ldots\ldots(12)$$

From equation (12) we see that the change in output voltage for a given change in input volts reduces as we increase A. Thus in a typical case, if $k = 2/3$ $Vin = 450$ $Vo = 300$ $Vr = 150$ and $A = 100$ then $n = \frac{1}{2}$ from equation (11) and a 10 per cent change in Vin results in a change in output voltage $\delta Vo = 45 \frac{dVo}{dVin} \simeq 0{\cdot}6$ V, i.e., a change of 0·2 per cent.

The output voltage from the supply can be varied over quite a wide range, as previously mentioned, by variation of n, the tapping point on the potentiometer R, which is connected across the output terminals. Changes in load current drawn from the supply would result in changes in the voltage dropped across the internal impedance of the power supply. Therefore if the internal impedance of the supply is Z the equation of the circuit becomes

$$Vo = kVin - IZ - A\delta V$$

where I is the load current

$$\text{and } \frac{dVo}{dI} = \frac{-Z}{1 + An.}$$

Now $\frac{dVo}{dI} = -Zeff$ where Zeff is the apparent output impedance of the circuit.

$$\text{Hence } Zeff = \frac{Z}{1 + An}$$

Using the figures from the previous example, and taking $Z = 500$, we see that

$$Zeff = \frac{500}{51} \simeq 10\Omega$$

Hence, a change in load current of 100 mA would result in a reduction in output voltage of 1 V.

(b) *Video frequency valve-voltmeters*

The video frequency valve-voltmeter is an instrument designed to measure either the peak or mean value of a signal within the frequency range from a few cycles per second up to several megacycles per second. The voltage range of the instrument is generally selected by means of a panel switch permitting full-scale deflections of the meter from a few millivolts up to several hundred volts in multiples of $\sqrt{10}$. In common with other voltmeters, the input impedance is made as high as possible, and a typical value is 1 MΩ shunted by 10$\mu\mu$F. Fig. 12 is a schematic diagram of a typical instrument in which the input voltage is taken via a frequency compensated voltage divider to the grid of a cathode follower. The load resistor of the cathode follower is tapped to provide the required values of full-scale deflection of the instrument.

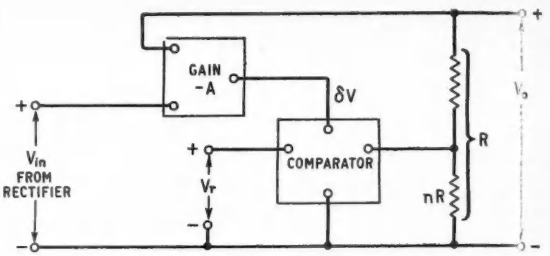


Fig. 11

The output from the cathode follower is then amplified by a feedback amplifier, which in turn feeds a diode detector circuit. As the output from the cathode follower may be of the order of 10 mV for full-scale deflection on the lowest range of the meter, and the diode circuit must be operated at a level of several volts in order to provide good linearity, the overall gain of the amplifier must be in the region of 1,000. Now the gain of the amplifier will be a function of the mutual conductance of the valves, electrode potentials and the frequency of the input signal; and if an overall accuracy of indication of, say, 2 per cent is required, then the gain of the system must be constant to the same degree of accuracy. It has already been shown that this can be achieved with a feedback factor of 10, and therefore the intrinsic gain of the amplifier must be of the order of 10,000. In order to reduce variations in the intrinsic gain of the amplifier, the circuit is generally supplied with h.v. current from an electronically stabilised power supply which maintains the h.v. constant to within about 1 per cent for a mains voltage fluctuation of ±10 per cent.

Instruments of this type normally indicate peak or mean values of the waveform to be measured, depending upon whether the capacitor C shown dotted in the diagram is connected. The scale is generally calibrated in r.m.s. volts on the basis of a sine wave input; consequently the instrument is only accurate when the signal to be measured is a sine wave. If the waveform of the signal is other than sinusoidal, the r.m.s. value of the signal can be deduced from the indicated value in simple cases, i.e., if the input waveform is a symmetrical square wave the peak, mean and r.m.s. values are all identical; if the meter indicates mean values the r.m.s. value of the square wave is $\frac{2\sqrt{2}}{\pi} \times$ the meter indication.

(c) *Electronic ohmmeters*

These instruments are essentially electronic ammeters which are used to measure the current which passes through the resistance to be measured when connected in series with a known potential. As the thermionic valve is essentially a voltage operated device, it is necessary to transform the current to be measured into a voltage of suitable magnitude. This is done by means of the circuit of Fig. 13 in which the resistance to be measured Rx is connected in series with a standard resistor R_s and a known d.c. voltage E.

The value of R_s is chosen to be a very small fraction of the minimum value of Rx on a particular range of the instrument, i.e., if $R_s = \frac{Rx}{1{,}000}$, then the current through Rx is E/Rx to within 0·1 per cent. The d.c. amplifier is arranged to provide an output current which is accurately proportional to the input voltage, that is the volt drop across R_s. Thus, if the ratio of output current from the

amplifier to input voltage is G, then the deflection of the meter is given by

$$\theta = \frac{E}{Rx} \cdot R_s G.$$

It will be noted that the meter scale can be calibrated directly in terms of resistance, range switching being accomplished in decade steps by variation of R_s. The meter scale shape follows an inverse law. In order to obtain increasing resistance values when the pointer is deflected in a clockwise direction, it is necessary to employ a movement having a right hand zero, or, alternatively, to "back off" the meter with a steady current. The value of G required can be calculated as follows: let the d.c. supply E = 500 V and the highest resistance indication $= 10^{11}\ \Omega$. Then if the scale calibrations cover 1 decade, $R_s = 10^7\ \Omega$ and full-scale deflection of the meter is 1 mA.

$$G = \frac{Rx\theta}{R_s E} = 2\ \text{mA/V}.$$

Now an effective conductance of 20 mA/V can easily be obtained with a simple amplifier, thus allowing a feedback factor of 10 to be employed. As in the case of the video valve voltmeter, the h.v. supplies would normally be stabilised to increase the stability of the circuit. But owing to the fact that the output current of a d.c. amplifier drifts in value due to changes in contact potential, etc., in the input valve, it is usually necessary to provide a "zero setting" control for the circuit. Circuits are commercially available for the measurement of resistance over a wide range of valves, i.e., low ohmmeters which are capable of measuring down to the milliohm region and high resistance instruments which may be used to measure millions of megohms.

(d) *The sound analyser*

The sound analyser is designed to measure the relative amplitudes of the harmonic components contained in a complex wave. Such a complex wave may arise, for example, from a piece of industrial machinery, and the information obtained is useful in devising methods both to reduce noise and remove undesirable resonances. The sound wave is picked up by a microphone the output of which is amplified by means of a highly selective circuit, which in turn drives a meter circuit.

The amplifier circuit is generally of the twin-T feedback type already discussed, but provision is made to vary the tuning frequency over the audio frequency range. This is generally done by making the capacitors in the feedback network of Fig. 6 variable, and mechanically coupling them to a tuning scale. This provides a tuning scale of 10 : 1, range switching being obtained by switching the resistors in decade steps. A sensitivity control enables the meter deflection to be set to full scale at the fundamental frequency of vibration, the indication at any other frequency then being proportional to the percentage harmonic content of the signal.

Fig. 12

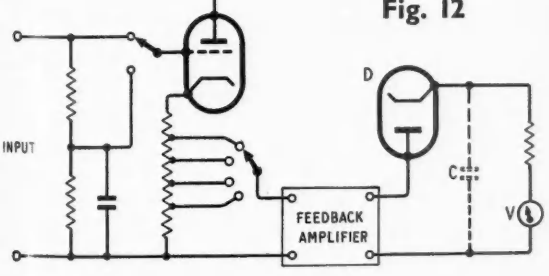
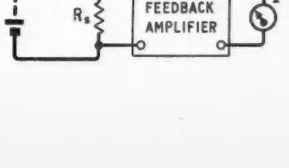


Fig. 13



As sound measurements frequently have to be made with the source of sound in its normal situation, the sound analyser must be compact and easily portable. Consequently instruments are usually designed to operate from dry batteries mounted in the instrument case. In addition to its uses for sound analysis, the analyser is of great use as a tuned detector in conjunction with audio frequency bridges, particularly those which use circuits in which the balance condition is dependent upon the frequency of the signal, for in these cases the balance point is often obscured by harmonics.

The author is grateful to Standard Telecommunication Laboratories, Ltd., for permission to publish the information contained in this article.

Ionospheric Scatter Equipment

Ministry of Supply Contract

LONG-DISTANCE radio communication, which is normally carried out in the h.f. band, has always had to face one serious obstacle, namely, that it is impossible to transmit on one frequency for twenty-four hours a day because, at certain times, the signals will fade and nothing can be received at the other end for some hours. Fortunately, different frequencies are effective for different times of the day over a given path, so that when transmission on one frequency is due to fade—and the time it will do so is reasonably predictable—the established procedure is to maintain communication whenever practicable by switching to a different frequency. This complication is obviously one to be avoided if at all possible, particularly as sudden fluctuations in sunspot activity may affect communication on all frequencies in the band, and the ionospheric scatter system of propagation, which uses the v.h.f. band, promises to overcome these difficulties. V.h.f. transmissions have, of course, been extensively used for many years, but the effective range has always been regarded as in the region of 30 miles. Now, however, it has been found that, by making use of the ionosphere (and particularly one ionised layer 50 to 70 miles above the earth), distances of 1,000 miles or even more can be spanned.

Marconi's Wireless Telegraph Co., Ltd., announces that a new range of transmitters and receivers specially designed for ionospheric scatter operation is now in production at the company's Chelmsford works. The Ministry of Supply has already ordered a considerable quantity of this equipment, including Type HS.201 transmitters, Type HD.65 frequency shift drives and Type HR.16 double diversity receivers. Both transmitters and receivers are designed to operate in the 35-55 Mc/s frequency band. The transmitters have a power output of 20 kW, the usual procedure being to operate two in parallel, using a split aerial system. The equipment is capable of high speed operation, frequency shift keying being employed.

Some of this equipment will be used to establish a communications system between the United Kingdom and Malta, with an eventual extension to Cyprus and the Middle East. Marconi's will undertake the complete installation and testing of the first part of this system to Malta.

Marconi's have also supplied a prototype transmitter to the Board of Admiralty for experimental work in ionospheric scatter propagation. This is a modified television transmitter with a power rating of 30-35 kW, sited at Gibraltar. The signals are beamed over the Bay of Biscay for scattering over Britain.

Clearer Catalogues

More Information Wanted on Street Lighting Equipment

By F. H. PULVERMACHER, A.M.I.E.E.

THE annual conference of the Association of Public Lighting Engineers again draws near, and with it will come the associated exhibition of street lighting equipment. The primary purpose of this exhibition is to place before users—Lighting Authorities, or Electricity or Gas Boards—the products of the manufacturers concerned, each of whom exhibits with the hope that his will be the lion's share. To this end stands are erected, sales staff despatched to the venue, and equipment set out to its best advantage. Such activity must necessarily involve a considerable expenditure, yet much of it can be regarded as wasted for the simple reason that many exhibitors do not appear to see beyond the end of the conference when, in the words of Longfellow, they "fold their tents like the Arabs, and as silently steal away."

Lost Opportunity

The basis of these remarks is that the author finds each year that the task of assessing the equipment is made very much more difficult by the lack of ordered information. It cannot be emphasised too strongly that the time when a manufacturer wants to be considered is when an order is about to be placed, or when approval is being given by an authority to the use of certain specified equipment. At such times the lighting engineer does not rely upon his memory, but turns to such printed particulars as he may possess, albeit his decision may be influenced by what he remembers having seen and heard at the conference. It is now that the errors and omissions of the exhibition come to roost.

Firstly, there is the worst case of all, the manufacturer who has rushed pell-mell to his stand with a new design. He has been in such a hurry that he has no technical description available, let alone performance figures. When the time comes the user may remember a lot of enthusiastic talk; but orders are placed on facts, not memories. Let a technical description, and, if possible, performance values be available for the "hot" new product if it is to be thought of at the critical time.

Secondly, and it is surprising how often this occurs, is the inability to say what the price of some new fitting will be. To the user this is a matter of prime importance, and it would be thought that suppliers would have realised this. A form of face-saving often adopted is to say that a quotation will be forwarded in due course if an address is left. But even when such a course is taken the promised figure often fails to materialise.

Next a plea must be made for an annual list to be available of a manufacturer's complete range. The reason for this is not so much to know what he does make, as what he does *not* make. Any lighting engineer worth his salt keeps particulars of all the equipment available, and one of his hardest tasks is to know when a certain line is discontinued. With the honourable exception of one of the biggest firms in the country who make a point of advising each variation, including price, as it occurs, there is a woeful laxity here. Whilst not asking for regular notification, it is felt that the omission of an article from a current list would imply that it had been discontinued, and serve as a notice.

Arising out of the previous paragraph, a list of products which can be depended upon to be up-to-date and complete can prove a very great help.

All manufacturers give some form of identification to their goods, but there is still much confusion here. Strange to say, one of the largest firms in the country is the worst offender. This very well-known concern uses an appellation for some of its products, but not others. With some fittings the same type name is used for fittings of widely different designs, final identification being by the customary catalogue number. But in order to complicate matters, lanterns of different types are given the same catalogue number. A range of fittings, or columns, should have a descriptive title, or number, for each different design, and a differentiating catalogue number for every variant. Alternative optical systems should be treated as variations, as should mounting entries, so that quotation of the catalogue number alone will ensure delivery of the required equipment. There must be no ambiguity in this respect.

Turning to technical information, this chiefly applies to lanterns and should cover the following as a minimum: Use; size and type of lamp; specification of body; optical system, including protective bowls; focusing arrangements; mounting; total light output for given size of lamp; direction intensity ratio.

Whilst the provision of both iso-candela and polar curve diagrams are desirable, the latter are more readily appreciated by semi-technical users, and therefore should be given preference. It would be of considerable assistance if all such diagrams were to a common size, 3in overall is suggested, rather than the many approximations to that size that are now published. Even so, any size is better than a complete absence of such curves.

It is to be hoped that equipment makers will give serious consideration to these critical comments, an action they would undoubtedly take if they realised the prejudice that can be engendered by confusion, verbosity, or worst of all, absence of information. In place of this state let them adopt uniformity, clarity and comprehension in the proclaiming of their wares.

Institution of Production Engineers

THE annual dinner of the Institution of Production Engineers is to be held at the Dorchester Hotel, London, on Friday, 5th October, when the principal speaker will be the Minister of Labour and National Service, Mr. Iain Macleod.

At the dinner the president, Mr. E. W. Hancock, M.B.E., is to make the following awards for papers presented in the 1954-55 session:—Silver medal for the best paper by a member to Mr. R. N. Marland, B.Sc., director and works manager, John Wright & Co., Ltd., for "A Job Evaluated Wages Structure." Silver medal for the best paper by a non-member to Messrs. J. A. Stokes, B.Sc., and N. Milne, B.Sc.(Eng.), of the B.T.H. Electronics Engineering Department for "Electronics as an Aid to Production." The Lord Austin Prize is to be presented to Mr. S. A. Onions, senior planning engineer, Wilmot Breeden, Ltd., for "Welding Distortion Problems Encountered in the Gas Turbine Industry."

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Area Board Efficiency

IN his admirable article in the *Electrical Review* of 17th August Mr. Bolton has not only continued his interesting study,[1] giving results for later years, but also has gone some way to meeting criticisms levelled against his methods. Unfortunately, in the latter respect, he has not gone far enough.

It is essential to his thesis that the fixed assets of distribution systems be allocated in some ratios to various factors of which consumers and kilowatts of maximum demand are probably the most important. The scientific tool for solving this problem is that branch of statistics known as regression analysis. The solution yielded by this method (which may not be correct, but is the most accurate obtainable by any method from the data available) is that the fixed assets should be allocated at rates of about £4 per kilowatt and £47 per consumer.[2]

Mr. Bolton's reasons for rejecting this solution are obscure. It is pointless to refer condescendingly to regression analysis as a sick child: it is not, despite many attempts to strangle it; but it is unpopular, like most children who prove wrong the cherished hunches of their "elders and betters." Unfortunately for the gypsy Petulengros of this world, and particularly of engineering, statistics is exactly what Laplace called it "*n' est que le bon sens reduit au calcul*"; as such it has an unassailable advantage over the crystal ball—it gives the same unequivocal answer to all questioners.

Before rejecting the scientific solution as "unacceptable," three questions should be answered:—

(i) Why does Mr. Bolton prefer his Fig. 2 (reference 1) to my Fig. P (reference 2), when Fig. P is clearly the better fit?

(ii) What criterion of fit has he used? I have used "least squares of the residual deviations," which leads, correctly applied, to my results.

(iii) How does Mr. Bolton, or Mr. Carne, reconcile figures of £15 (or nothing) per consumer with figures of £40 to £60 per house connected, quoted by Mr. Howarth in the discussion on Copland's paper?[3]

Newcastle-upon-Tyne. R. A. HORE.

REFERENCES

[1] *Proc.* I.E.E. **102**, Part A, No. 4, Aug., 1955.
[2] *Proc.* I.E.E. **103**, Part A, No. 9, June, 1956.
[3] *Proc.* I.E.E. **99**, Part I, p. 95.

Mr. D. J. Bolton has seen Mr. Hore's letter and sends us the following observations:—

I will reply to Mr. Hore's third question first because this will dispose of the other two also. Mr. Howarth's figure of £40 to £60 per house connected referred to the present-day cost per new consumer whereas my figure was an allocation of past capital expenditure amongst the total of existing consumers. At the time of my paper approximately three-quarters of these consumers had been connected before the war, spread over a period when equipment prices were about one-third of their present figure. An average of pre-war and post-war costs in these proportions will therefore give a resultant of about one-half of the present-day cost. Moreover, a certain amount of the £40 to £60 will be demand-related. Mr. Howarth's figure for new connections is therefore quite consistent with my figure of £18 to £21 for the average cost of existing ones, and quite at variance with Mr. Hore's calculation of £47.

The results of this calculation are unacceptable for another reason, namely, that they indicate only £4 per kilowatt for the demand-related component of the distribution capital. My revised allocation is based not on the fit of the curves but on an examination of the actual assets making up this capital, many elements in which (such as the size of the cables and transformers) are proportional to maximum demand and cannot possibly be covered by so small an allocation as £4 per kW. It would be fair to say that not one of the many other contributors who took part in the I.E.E. discussion would accept anything like so small a figure.

Having shown, on the evidence he himself brings forward, that Mr. Hore's figures are unacceptable, the question remains to be answered—why does regression analysis (which is the correct mathematical tool for the purpose) appear to give the wrong answer? The problem is to divide a known total capital expenditure into its demand-related and consumer-related components, the two varying in the same sense as the Board size varies, and giving (effectively) only thirteen sets of data. If some Boards had large demands and almost no consumers whilst other Boards were in the reverse position the problem could still be solved mathematically, but as in fact the demand/consumer ratio has a range of only about $1\frac{1}{4}:1$ the number of points is too small for regression analysis to give a determinate answer.

Tax Allowance for Subscriptions

I WAS very surprised to find in the letter from "Unqualified" in your issue of 24th August the statement that where qualifications are necessary to the job, the "Inland Revenue will generally concede that the annual subscription can be allowed against income tax."

In the case of my own employer and a large associated company, the employers insist that employees in certain jobs shall hold continued membership of certain organisations. On presenting our case to the Inland Revenue we had a reply which stated "Your membership subscription is not considered to be incurred in the performance of your duties but merely so that you can continue to hold your employment and consequently no deduction can be given to you for this expense."

I should be very interested to learn of anyone who has had a more favourable reply.

"QUALIFIED."

I.E.E. South Midland Centre

THE opening meeting of the session and the annual general meeting of the South Midland Centre of the Institution of Electrical Engineers, at which Mr. C. J. O. Garrard, M.Sc., M.I.E.E., will give his inaugural address as chairman, will be held at the Grand Hotel, Birmingham, on Monday, 1st October, at 6 p.m., and will be followed by a conversazione. Facilities are limited at the latter and members have been asked to apply for tickets.

INDUSTRIAL NEWS

Monopolies Commission References

In accordance with the provisions of the Restrictive Trade Practices Act, 1956, the Board of Trade has given directions to the Monopolies and Restrictive Practices Commission that the following existing references are to be continued:—Standard metal windows and doors; electronic valves and cathode ray tubes; tea; and chemical fertilisers. The references on windows and doors and on tea will be continued in their existing forms. The Commission's report on electronic valves, etc., is now to be a factual report only. It is expected that these three reports will be received shortly.

The references which are being allowed to lapse are those on electric street lighting equipment, steel frames for buildings, and electric batteries. These references were made during the summer of 1955 and work on them, which was not far advanced, was suspended when the Government's intentions as regards existing references were announced during the second reading debate on the Restrictive Trade Practices Bill.

The general requirement on common prices and agreed tendering is also being allowed to lapse. Agreements embodying such practices will be subject to registration as from 30th November provided that Parliament approves the Registration of Restrictive Trading Agreements Order, 1956, which was made on 2nd August.

U.S. World Trade Fair

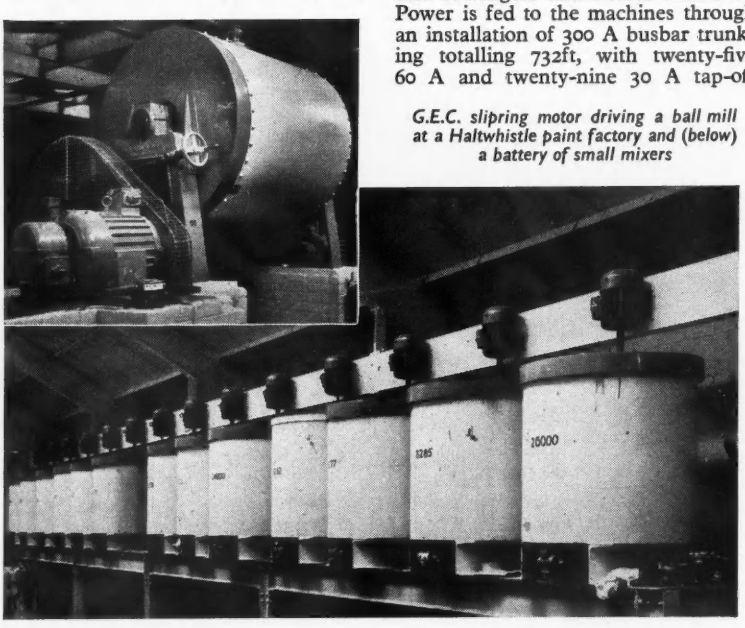
A booklet has been received from the organisers of the World Trade Fair to be held in New York from 14th to 27th April next year. The exhibition, at the new Coliseum, New York, will cover an area of over 300,000 sq ft on four floors. It will be divided among nine groups in one of which, that including national pavilions, the United Kingdom Government will have a large information stand. Group 5 will include domestic electrical appliances and radio and television equipment and Group 8 will contain, among other exhibits, electronic equipment, scientific instruments and electrical equipment and motors.

The British and Commonwealth Office of the World Trade Fair is at Dudley House, 36-38, Southampton Street, London, W.C.2.

Paint Factory Electrification

Extensions completed recently at the Haltwhistle (Northumberland) factory of Smith & Walton, Ltd., mark a new stage in the development of this old-established paint manufacturing business. As a result of continuous expansion, it became advisable to change over the existing works from d.c., privately generated, and take a bulk three-phase supply from the North Eastern Electricity Board. A modern electrical installation was planned and installed by the firm's Electrical Department. The principal items of the electrical distribution system and drives for the factory extensions and change-over have been supplied by the General Electric Co., Ltd.

Oil switches have been installed for controlling the four main 400 A feeders, and supplies are distributed through ten main departmental switchboards made up from G.E.C. "MW" type iron-clad switchgear and busbar chambers. Power is fed to the machines through an installation of 300 A busbar trunking totalling 732ft, with twenty-five 60 A and twenty-nine 30 A tap-off units. Five isolator units, consisting of short removable busbar sections, have been provided for isolating portions of the trunking. Over 1,000 h.p. of G.E.C. totally enclosed fan-cooled motors have been installed.



G.E.C. slipring motor driving a ball mill at a Haltwhistle paint factory and (below) a battery of small mixers

Industrial Chemical Production

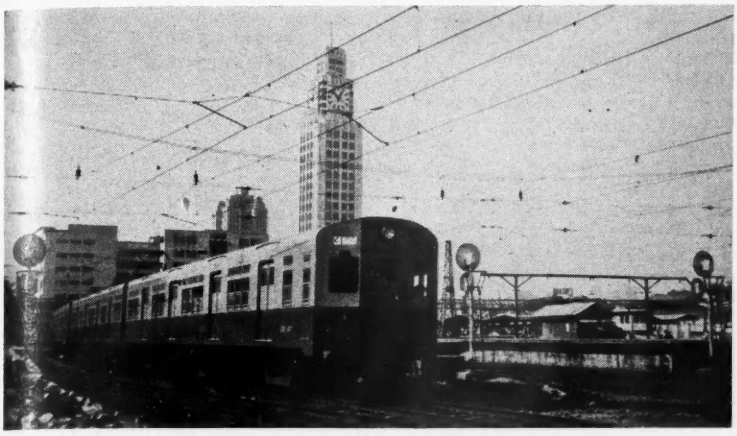
Important developments in the manufacture in Great Britain of new industrial chemicals from petroleum are announced by Monsanto Chemicals, Ltd. The company plans to spend some £8½ million on the first stage of a long term expansion programme. A new factory will be constructed on a 100-acre site alongside the Fawley, Hampshire, refinery of the Esso Petroleum Co., Ltd., from which Monsanto will draw feedstock for conversion into a wide variety of raw materials for use in the plastics, textile, rubber, paint, paper and other manufacturing industries.

The first plant to be erected will be for the manufacture of 10,000 tons of polyethylene a year. Survey work is being carried out on the site, construction will begin shortly and production is scheduled to start in 1958. The next products in the company's programme will be copolymers of acrylonitrile, butadiene and other monomers. The copolymers have a wide range of uses in the rubber, paint, plastics, paper and other industries. Following this a major plant is to be constructed for the manufacture of acrylonitrile, an important chemical not yet made in this country.

Electric Winders for South Africa

A number of orders have been received recently by the Metropolitan-Vickers Electrical Co. Ltd., for large electric winders for coal and gold mines in South Africa. These include a 4,300 h.p. automatic a.c. geared equipment for the General Mining & Finance Corporation to drive a tower-mounted four-rope friction winder incorporating a new system of control. Winding will be carried out continuously under completely automatic control, utilising grid-type rotor resistances and closed loop dynamic braking with d.c. supply from a mercury arc rectifier. Automatic operation will be initiated by skip loading arrangements. The winding depth is 5,000ft, and the normal load 15 short tons of ore in balanced skips. It is claimed that this is the largest friction drum winder so far developed.

Two 6,700 h.p., r.m.s. (14,200 h.p. peak) Ward-Leonard geared double drum winders ordered by New Consolidated Goldfields, Ltd., will be the largest in South Africa. They will be the largest winders in the world having completely automatic closed loop control, and will be the first automatic winders in South Africa to employ the



A Metropolitan-Vickers electric train in service in Brazil

laminated exciter system, the company's latest closed loop development.

New Consolidated has also ordered four 5,200 h.p., a.c. winders with dynamic braking. One equipment will be winding in the same shaft as the Ward-Leonard equipments mentioned above.

Trawler Diesel-Electric Equipments

The General Electric Co., Ltd., has received an order for two 2,000 s.h.p. diesel-electric equipments, one for each of two fish factory trawlers now being built by William Simons & Co., Ltd., at Glasgow for Christian Salvesen & Co., Ltd., of Edinburgh.

Anglo-Swedish Telephone Cable Project

It is announced in Stockholm that the Swedish post and telegraph authorities are applying to the Government for permission to discuss with the British Post Office plans to lay a direct submarine telephone cable between Sweden and Britain.

The project is for a coaxial cable permitting 36 simultaneous telephone conversations as well as telex and telegraphic communication. The estimated cost is roughly Sw.kr.20 million (£1·4 million), which would probably be shared equally by the two countries concerned. The cable would possibly be ready for use in 1960.

Electric Traction in Brazil

One of the electric trains supplied by the Metropolitan-Vickers Electrical Co., Ltd., to the Central Railway of Brazil is seen in the accompanying photograph leaving the Dom Pedro II station at Rio de Janeiro. The company has in hand a £7,000,000 contract for this railway, covering the supply of 50 three-coach train units and 50 motor coaches, together with 100 additional sets of electrical equipment for trailer cars. The coaches themselves are being built by the Metropolitan-Cammell Carriage & Wagon Co., Ltd., acting as sub-contractors. Seventeen of the three-coach train units have been shipped to Brazil.

Designers at Work

A special display, to illustrate the work of the Council of Industrial Design's Record of Designers, is to be held at the Design Centre, London, from 10th to 29th September. The aim of the Record, which has over 2,000 designers on its books, is to provide the manufacturer who has a design problem with a short list of possible consultant or staff designers with special qualifications for the particular job. The exhibition will show actual examples and photographs of some of the work done as a result of the Record's recommendations over the last few years.

New F.H.P. Motor Factory

Plans have now been approved and contracts placed by Brook Motors, Ltd., for a new factory at Honley, near Huddersfield. The 28½ acre site was formerly an amusement park. The new building will consist of three factory bays with north lighting and a flat-roofed section which will house administration and welfare, etc., all accommodation being on one floor only. The total floor area will be 75,000 sq ft and the works area will be 570ft long by 105ft wide.

It is intended to add additional bays in blocks of three with an ultimate area comprising nine bays, with an eventual total coverage of 16 to 20 acres. The rather long building has been chosen so that unidirectional production of fractional horse power motors may be planned on the most modern scale to give high output with minimum handling and labour. The present F.H.P. Motor Department at Empress Works will be transferred there together with a large number of the present personnel. After the first three months the number of employees at Honley is expected to be about 500.

Work is to start immediately on the building, which is scheduled for completion in twelve months' time. The site is in a country area surrounded by trees—there are about 400 poplar trees—and it is intended to leave all these standing. The building will be in stone and buff brick; the roof, of the continuous beam portal truss type, will be covered in green material, and should blend well with its surroundings. All combustion will be confined to heating by underfeed stokers giving a minimum emission of smoke. The architect is Mr. Noel Heppenstall, L.R.I.B.A.

More Efficient Fluorescent Tubes

As the result of improvements in phosphor manufacture in the Chemicals Division of Thorn Electrical Industries, Ltd., the company is able to claim increases in the efficiency of its Atlas "Double-life" fluorescent tubes of up to 7 per cent. The accompanying table gives the figures for lumen output now obtained from current production and indicates the predominance of the Atlas White 3,500 deg K. Former performance is shown in parenthesis.

Tube	5ft 80 W		4ft 40 W	
	At 100 hrs	Average through life	At 100 hrs	Average through life
White 3,500° K ...	4,800 (4,640)	4,320 (4,160)	2,560 (2,400)	2,320 (2,160)
Warm White ...	4,720 (4,640)	4,240 (4,160)	2,520 (2,400)	2,280 (2,160)
Daylight 4,500° K	4,560 (4,400)	4,080 (3,920)	2,440 (2,280)	2,200 (2,040)
Natural	3,680 (3,520)	3,200 (3,040)	1,920 (1,800)	1,680 (1,600)

Further improvements in fluorescent lamp efficiencies are also announced by members of the Electric Lamp Manufacturers' Association. A schedule of seven ratings from the 8ft 125 W lamp to the 18in 15 W lamp shows the improved average lumen output through the first 5,000 hours of life. For most of the "popular" ratings the increases in efficiency range from 2½ to 12½ per cent; some of the smaller lamps show greater increases—in the case of 2ft colour matching lamps of more than 30 per cent.

Cheaper Fluorescent Fittings

To decrease the gap between the prices of their instant-start and switch-start fluorescent fittings the A.E.I. Lamp & Lighting Co., Ltd., has reduced the price of all its 5ft and 4ft instant-start fittings in the 200-250 V range. Particulars of the reductions are given in the company's leaflet AF 124.

New E.A.W. Branch

A new E.A.W. Branch was formed at Congleton, Cheshire, on 24th July.

A welcome was given by the Mayor, Councillor W. H. Semper, B.A., J.P., and the Mayoress, Mrs. W. H. Semper, J.P., took the chair as president of the Branch. Other speakers were Mrs. A. L. Hayes, E.A.W. area organiser, and Mr. R. Bond, A.M.I.E.E., sub-area manager, Midlands Electricity Board. The officers are: chairman, Mrs. R. Bond; hon. secretary, Mrs. B. Salmon; hon. treasurer, Mrs. G. Neville; magazine secretary, Mrs. R. Clarke; and social secretary, Mrs. Mountford.

Transducer Order

A Ministry of Supply contract for pressure transducers to the value of £25,000 has been secured by J. Langham Thompson, Ltd., a member of the Camp Bird Industries group.

"Osram" Lamp Sales Campaign

In addition to wide Press advertising and posters displayed at 3,000 outdoor sites, with illuminated signs and floodlit bulletin boards in main towns and cities, the new season's sales campaign of the General Electric Co., Ltd., for "Osram" lamps includes a series of four films which will be transmitted on commercial television in London, the Midlands and the North on Sunday evenings throughout the autumn and winter. They will feature the "Osram" lamp symbolised by the "humming-bird of light" with a flute accompaniment to convey the fluttering of wings. The films, a preview of which was given last week, are by Alexeieff, who at the International Film Festival in Venice in 1954 won a prize for originality.

One of the "Osram" sales aids for the coming lighting season, the "oyster shell" unit

Sales aids available include a cut-out for counters and small windows displaying the "Osram" "pink pearl" lamp emerging from an oyster shell and an animated version on the "housewife" theme. An animated illuminated unit depicts a house with an open window through which shines the slogan "Osram The Wonderful Lamp."

The "pink pearl" lamp is the theme of two of the three displays which will be supplied to contractors and Electricity Boards for exhibition in large windows. They show a mermaid seated on a rock basking in the light from a lamp shining from a newly opened oyster shell. The other display for large windows shows a housewife out shopping, basket in hand, and the words "Butter and cheese, some meat, two stamps . . . and I haven't forgotten my Osram lamps!" Translucent trapinex transfers will continue to be supplied and fixed by the dealer service

This nation-wide campaign will be supported by literature including new editions of the three-part "Osram" catalogue and the lamp and tube price booklet. For the domestic user there will be a publication emphasising the advantages of using "pink pearl" lamps and including details of all other "Osram" lamps for domestic lighting. Separate campaigns cover street lighting, vehicle bulbs and lamps for photographic use.

Board Employees Commended

Two employees of the North Eastern Electricity Board were commended at an inquest at Sunderland for their efforts to rescue a 14-year-old boy who had climbed an electricity pylon and received fatal injuries. The inquest was on Colin Moore of Shiney Row. Mr. R. Ayre, substation attendant at Herrington Burn, said he heard the sound of an explosion, and the telephone switchboard burst into flames. He did not know whether the explosion had cut off the electricity at the pylon, but he climbed to the platform where Moore was lying and tore off some of his burning clothes. Another employee, Mr. J. Higgins, helped him and later called the fire brigade. Moore was lowered to the ground on a stretcher, and died 17 days later in hospital. Returning a verdict of "Death by misadventure," the Coroner (Mr. Cuthbert Morton) commended Mr. Ayre and Mr. Higgins for their rescue efforts. He added that the Electricity Board had taken every precaution to prevent unauthorised people climbing the pylons. A barbed wire barrier had been erected and there were also three warning notices.

Automation in Offices

The use of electronic computing machines will take the gamble out of management decisions in industry and commerce. This is one of the many aspects of automation in offices discussed at the annual summer school of the Institute of Cost and Works Accountants at St. Catherine's College, Cambridge, this week. The point is made in a paper by Mr. G. J. Pierce, deputy chief accountant of the Bristol Aeroplane Co., Ltd. Mr. Pierce underlines the fact that pre-planning by electronic computers is a science very much in its infancy.

German Railway Modernisation

The Western German Federal Railways have announced that orders are to be placed for 1,044 electric and diesel-powered locomotives to the total value of about D.M.500 million. In the course of the modernisation programme extending over the next few years it is planned to order a further 3,000 diesel locomotives. Rail omnibuses, which are diesel-operated, have proved particularly profitable, the operating costs being 50 per cent lower than for steam locomotives.

City and Guilds Institute

The seventy-sixth annual report of the City and Guilds of London Institute (Gresham College, Basinghall Street, London, E.C.2) for the year ended 30th September, 1955, contains an illustration of the armorial bearings granted to the Institute, the text of the Patent of Arms, together with the achievement depicted in the margin and a note on the allusions. The cipher adopted by the Institute is also shown. Referring to the Department of Technology, the report says that entries for the Institute's examinations in 1955 exceeded 100,000 for the first time. The Institute has also issued its "General Regulations, 1957," including the 1956-57 calendar, timetable and fees for examinations; and "Regulations and Syllabuses: Telecommunications and Electrical Subjects, 1956-57," which costs 4s.

Arc Melting in India

For the production of steel castings, the Indian Iron & Steel Co., Ltd., is to install a second 2,000 kVA Birlec "Lectromelt" arc melting furnace. Giving an output of approximately 2 tons per hour, the furnace has a shell diameter of 8ft and a capacity of 4 tons. Since 1946 Birlec have been commissioned by various Indian companies to build a total of 22 arc melting furnaces in a wide range of capacities.

A.E.I. Lamp & Lighting Scottish Showroom

On 30th August a new A.E.I. Lamp & Lighting Co. showroom with a floor area of about 1,600 sq ft was opened at the company's new regional headquarters at 74, Waterloo Street, Glasgow. The interior has been designed by Messrs. Basil Spence & Partners and Mr. J. Hardie-Glover, Edinburgh, the architect in charge.

The requirements were for a simple shell which by its treatment could house exhibitions and not clash with individual displays. The walls and ceilings are therefore matt black. Invertrunking runs across the showroom at a height of 10ft, giving flexibility for any required lighting

A group at the opening of the new Glasgow showroom : Messrs. R. Whetmore (who designed the exhibition), J. Hardie-Glover (architect in charge), O. W. J. Farmer (publicity manager, A.E.I. Lamp & Lighting Co.) and R. E. Hopkin (publicity division)

scheme. The reception area is situated off the main showroom; here Mazda "Module" fittings are set into an acoustic tile ceiling. Behind the reception area there is a kitchen fully equipped with Hotpoint units. Window lighting is by fluorescent lamps above plastic louvres and this lighting also illuminates a fascia panel which runs at an angle behind each window.

The first exhibition is called "System of Lighting" and, apart from certain additions, is similar to the "Lighting and the Architect" exhibition seen in London in April, 1955. It is intended to interest architects and engineers concerned with lighting systems which may be integrated with the fabric of the buildings in which they are used. The exhibition demonstrates some of the principal lines of approach followed by A.E.I. Lamp & Lighting Co. engineers. The exhibition was redesigned for the Glasgow showroom by Robert Whetmore, South Kensington, and the contractors were R. Fox, Ltd., Hampstead.

Damascus Fair

The third Damascus International Fair which was opened on 1st September is the first at which there has been a United Kingdom section. It consists of a 20,000 sq ft pavilion and a similar area of outdoor space. In the pavilion thirty stands display the products of a hundred British firms and there are nine outdoor stands. The section has been organised by British Overseas Fairs, Ltd., a subsidiary of the Federation of British Industries.

A number of British manufacturers are represented on a composite stand arranged by the British Radio Equipment Manufacturers' Association. Pye, Ltd., have set up a television transmitter and studio for the broadcasting of programmes throughout the Fair and they also display radio, television and telecommunication equipment. The following also have exhibits:—Berec (Gt. Britain), Ltd. (flashlight and radio batteries), the Brush Group, Ltd. (diesel engines, generators, pumps, etc.), Bush Radio, Ltd., E. K. Cole, Ltd. (radio and television sets), A. C. Cossor, Ltd. (television and radio equipment), General Electric Co., Ltd. (radio receivers, amplifying equipment and radio and lighting batteries), Kolster-Brandes, Ltd. (radio and television apparatus), James Neill & Co. (Sheffield), Ltd. (hacksaw blades, permanent magnets, magnetic chucks, etc.), Regentone Radio & Television, Ltd., and Thorn Electrical Industries, Ltd. (Ferguson television and radio receivers).

In addition a number of British manufacturers are represented by their Syrian agents, including the Aluminium Wire & Cable Co., Ltd., James Beresford & Son, Ltd., Blackstone & Co., Ltd., the D.P. Battery Co., Ltd., Dimplex, Ltd., the Electrical Equipment Co. (Leicester), Ltd., Electrolux, Ltd., Erskine, Heap & Co., Ltd., Hoover, Ltd., Lancashire Dynamo & Crypto, Ltd., R. A. Lister & Co., Ltd., Joseph Lucas (Export), Ltd., Metropolitan-Vickers Electrical Export Co., Ltd., Mullard Overseas, Ltd., F. Perkins, Ltd., Ruston & Hornsby, Ltd., Sigmund Pumps, Ltd., John Thompson, Ltd., and Wilkins & Mitchell, Ltd.

Battery Agreement

Alkaline Batteries, Ltd., Redditch, Worcs., has acquired all the share capital of Patterson Lamps (1953), Ltd., mine lamp manufacturers, of Gateshead-on-Tyne. The sales and technical personnel of Alkaline Batteries will now join forces with the Patterson staff and work as one unit, selling all types of lamps throughout the country.

Technical Education in Scotland

With the advice and assistance of Regional Advisory Councils for Technical Education, Directors of Education and principals of Central Institutions, the Scottish Education Department has compiled a "Directory of Day Courses of Technical Education in Scotland."

Types of courses detailed include part-time courses leading to National or City and Guild of London certificates, full-time courses for college diplomas and the associateships and university degree courses available in affiliated technical colleges.

The first part of the directory lists the courses and cross references from the list are made to a second section consisting of a region by region list of centres where these courses are provided. Almost all the part-time courses listed in the directory are provided under day-release arrangements whereby young people attend college one day a week with pay to continue their technical studies, a form of technical education much less developed in Scotland than in England.

The directory is designed for the use of employers, personnel managers, apprentice supervisors and others in industry and commerce concerned with education and training. Copies may be obtained from the secretaries of the five Regional Advisory Councils, at Heriot-Watt College, Edinburgh; Royal Technical College, Glasgow; Robert Gordon's Technical College, Aberdeen; 32, Bell Street, Dundee; or 33, Academy Street, Inverness.

Fighting Inflation

Under the general heading of "The Management Challenge of 1957" five speakers will present their answers to the question "Can we sell our way out of inflation?" at a conference organised by the Incorporated Sales Managers' Association in collaboration with the British Institute of Management at the Royal Festival Hall, London, on 9th October. The speakers will be Lord Woolton, Mr. Hugh Weeks, Mr. J. C. George, M.P., Mr. Montague Prichard and Sir Patrick Hamilton.

Housecraft Examinations

The results of the electrical housecraft examinations held at various centres throughout the country last June are announced by the Electrical Association for Women. In the E.A.W. Certificate examination for demonstrators and saleswomen 129 candidates qualified, 11 gaining distinction, and in the examination for teachers 50 candidates qualified, four with distinction.

Trade Announcements

Elliott Brothers (London), Ltd., announce that they have concluded a licence and technical agreement with the Swartwout Company of Cleveland, Ohio, by which they become the manufacturing licensee and sole agents in the British Commonwealth (except Canada) and Europe for the complete Swartwout range of "Autronic" miniaturised all-electronic control and transmission equipment.

Smith's Delivery Vehicles, Ltd., makers of N.C.B. electric vehicles, have decided to extend the guarantee period on all but certain proprietary items from one to two years.

Proposed Change of Name

At the annual meeting of Hackbridge Cable Holdings, Ltd., on 21st September, it will be proposed that the company's name shall be changed to Hackbridge Holdings, Ltd.

GENERATION AND DEVELOPMENT

More Small Stations to be Closed

Following a survey of further small power stations (up to 10 MW) with high operating costs the Central Electricity Authority has decided to close those at Horsham, Bideford, South Molton, Okehampton, Monmouth, Darwen, Leigh (Lancs) and Queensferry stations and five others with a total capacity of 9·1 MW (Canterbury, Cromer, Bridgend, Milford Haven and Barnsley) as soon as reinforcements of the Area Boards' local systems or the d.c./a.c. change-over programmes permit, probably at the end of the summer. This information was given at a recent meeting of the National Joint Advisory Council reported in *Electricity*, the journal of the C.E.A. It was stated that suitable employment could be found for the people who would be displaced. After trade union members had expressed their appreciation of the manner in which the Authority had dealt with personnel affected by the closing, Lord Citrine suggested that a list of stations likely to become obsolete should be prepared with a view to giving twelve months' notice of intention to close, if possible, and the Council welcomed this offer.

Rural Supplies in Northumberland

A report on the progress of the rural electrification scheme in the North Northumberland area was submitted to a meeting of Berwick and Borders Farmers' Union. The South of Scotland Electricity Board stated that the electrification of the Shoresdean area would be completed by the end of this year; work in the Haggerston and Cheswick areas would finish next spring; and the Duddo and Etal schemes would be completed at the end of 1957. It was stated that the Duddo scheme was due for completion sooner than expected.

Eastleigh Overhead Line Inquiry

Mr. W. L. M. French, of the Ministry of Fuel and Power, held an inquiry recently at Eastleigh Town Hall into objections by the Eastleigh Borough Council and Hampshire County Council to a proposal by the Southern Electricity Board to erect a low voltage overhead line along Chestnut Avenue.

Mr. F. G. Wrapson (S.E.B.) said that twelve properties would be connected as a result of the scheme, which would involve the erection of eight poles. The cost was £479 while with an underground cable it would be £1,532. Replying to Mr. D. A. Tranah (deputy town clerk, Eastleigh) he said that the Board had not given any special consideration to amenity. The over-riding consideration was the cost of the scheme. The estimated revenue was less than the statutory 20 per cent of capital per annum. The possibility of placing the line at the rear of the premises had not been investigated.

Mr. Tranah said that the objections were purely on a question of amenity. The section of Chestnut Avenue concerned was one of the most attractive corners of Eastleigh, a town which on the whole was not over-provided with such spots. The eight thatched cottages along its length indicated its character. The Council was not trying to be obstructive and had welcomed the Board's original intention to lay the cable underground. Further up the road a new factory had been supplied by underground cable.

In reply it was stated that the Board was quite prepared to consider putting the line behind the properties but there were disadvantages to this. In the case of the factory, there was a large underground cable within a few yards of the site.

Meaford "B" Station

On page 371 of our last issue in the article dealing with Meaford "B" generating station it was stated that the three-pass condensers were supplied with cooling water by four Allen West 40,000 gal/min c.w. pumps. The four pumps concerned were made by W. H. Allen Sons & Co., Ltd.

Ireland's Power System

The generating stations and transmission system of the Electricity Supply Board, Ireland, are briefly described and illustrated in a well-produced booklet of 68 pages and a folding map which has been published by the Board. The booklet is divided into sections covering hydro-electric, peat-fired and coal- and oil-fired stations, the principal technical particulars of each station being given in tabular form. Finally details are given of the Finglas 110 kV substation.

Substation Accident

Four men were injured, one fatally, when an explosion occurred in a substation of the South Wales Electricity Board at Cardiff on 25th August. The roof and interior of the building were severely damaged.

OVERSEAS

Market Needed for Labrador Power

Mr. A. W. Southam, Canadian representative of the British-backed British Newfoundland Corporation, said at St. John's, Newfoundland, recently that surveys had been completed of the Grand Falls on the Hamilton River and further development was dependent only on the finding of a market for the electricity produced. Mr. Southam said that the British Newfoundland Corporation was negotiating with about half a dozen large electricity consumers. The shape of the river made it possible for the full 4,000,000 h.p. potential to be harnessed in one power house but it also meant that the first development would have to be substantial, about 1,000,000 h.p. Only a few projects in the world were comparable with the proposed development.

French Atomic Power Station

Electricité de France is to construct its first nuclear power station at Avoine, Indre-et-Loire. It will follow the general scheme of the two installations at Marcoule of the Commissariat à l'Energie Atomique, i.e., natural uranium fuel, graphite moderator and CO_2 coolant. The ultimate capacity of the station will be between 250 and 300 MW, and it is hoped that the first section of 60 MW, costing 10 milliard francs (£10 million), will be put into operation by the end of 1959.

TRADE MARK APPLICATIONS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 15th September:—

PETBOW (design). No. 745,798. Class 7. Engines and motors, none being for land vehicles; welding machines and electric generators; parts; compressors (machines); and non-automatic mechanisms for controlling the operation of machinery and of motors.—Petbow, Ltd., Richborough Works, Sandwich, Kent.

Nos. B740,699 and B740,701 (design). Class 9. Electric switches, thermostats, electric safety fuses (cut-outs) and electric current regulators. — Theodor Hermann Stiebel, Holzminden, Weser, Germany. Address for service, c/o A. A. Thornton & Co., Napier House, 24-27, High Holborn, London, W.C.1.

CUSHYMOUNT. No. 748,049. Class 9. Electrical apparatus and instruments; radio, scientific, nautical, surveying, photographic, cinematographic, optical, weighing and measuring apparatus and instruments; and parts.—Metalastik, Ltd., Evington Valley Road, Leicester.

No. 751,285 (design). Class 9. Radio apparatus, radiograms, television apparatus, sound record players, sound recording apparatus and parts.—Boyd, Ltd., Talbot House, Talbot Street, Nottingham.

DENNIS THE MENACE. No. 752,592, and No. 752,741 (design). Class 9. Cinematographic films prepared for exhibition; television and radio instruments and apparatus; sound reproducing and sound recording instruments and apparatus; and optical projection instruments and apparatus; and parts.—D. C. Thomson & Co., Ltd., Courier Buildings, Albert Square, Dundee.

SIDLEEN. No. 753,993. Class 9. Scientific, photographic and cinematographic apparatus and instruments; electrical apparatus and instruments; and coin or counter-freed apparatus.—Associated Brassfounders Birmingham, Ltd., Willesden Works, Old Oak Lane, London, N.W.10.

LANTHE. No. 753,691. Class 10. Electric light fittings.—Ian Heath, Ltd., 16-17, New Bartholomew Street, Birmingham, 5.

NEW ELECTRICAL EQUIPMENT

Silicone Insulation

A wide range of silicone insulation is now available from the MICANITE & INSULATORS CO., LTD., Empire Works, Blackhorse Lane, Walthamstow, London, E.17. This meets Class "H" requirements as set out in B.S. 2757: 1956.

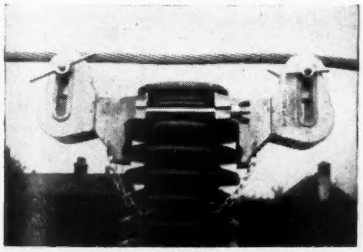
The range includes silicone bonded micanite sheets, both hard and flexible, V-rings and tubes of all shapes and sizes, silicone glass and glass/mica sheets and tapes and silicone bonded laminated glass fabric. The last-named material can be supplied in sheets, rods, tubes and machined parts.

The large silicone bonded laminated glass block (shown left, background, in the illustration) is nearly two inches thick and gives a good indication of the advances which have been made in processing silicone materials.

Line Running Block

A new 33 kV line running block has been developed by the EUREKA ENGINEERING CO., Masons Hill, Bromley, Kent. This equipment consists of aluminium stirrups insulated with rubber which clamp round the neck of the insulator and these can be developed for most types of 33 kV insulators. An interchangeable roller bracket which incorporates the dropping away mechanism is bolted to the stirrup. The conductor can be strung over the insulator, and after tensioning it can be taped and lowered into position in the insulator groove.

Line running block fitted to a 33 kV post insulator



Left: Selection of M. & I. silicone insulation

Below: Magnet end view of the Igranic-Stromag clutch

Automatic "Argonarc" Welding

BRITISH OXYGEN GASES, LTD., North Circular Road, London, N.W.2, have announced the introduction of the Model C automatic "Argonarc" welder for jigged components and the welding of cylindrical sections formed from flat sheets of metal.

The main feature of the machine is automatic arc length control, which is obtained by a welding head with a vertical travel of 16in. This will follow curves and undulations on the workpiece, at the same time maintaining an exact distance between the arc and the joint, ensuring a uniform weld deposit with controlled penetration. Water, gas, current and other controls are operated from a remote push-button control panel.

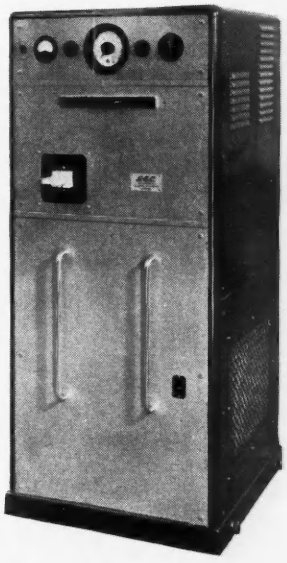
The Model C automatic head and control equipment as supplied is suitable for d.c. welding current only, but equipment for a.c. welding can be supplied if required. The unit comprises a water cooled machine welding torch with a maximum current capacity of 400 A d.c., a control panel and remote control switch.

Induction Heater

The GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2, has developed an induction heater having an output of 7 kW at a frequency of 500 kc/s which is equally suitable for use in repetition work or as a general purpose tool for processing batches of different articles.

The high frequency output is obtained from an oscillatory circuit using a single reliable valve which is supplied from a full wave rectifier circuit using six valves.

The circuits are protected by relays and fuses. The oscillator valve and the interior of the set are cooled by a filtered air blast and an anode current meter gives an indication of the power output. The heater is operated by push-buttons mounted on a separate box for fixing in a convenient position on a work table. A self-resetting process timer enables the heating cycle to be terminated automatically.



G.E.C. 7 kW induction heater with continuously variable output control

The generator occupies a floor space of less than 6 sq ft, and is 5ft 4in high. It operates from standard three-phase 50 c/s supplies and can be supplied with one or two work stations as required.

Electro-magnetic Clutch

The IGRANIC ELECTRIC CO., LTD., part of Metal Industries, Ltd., Universal House, 60, Buckingham Palace Road, London, S.W.1, is to manufacture a range of electro-magnetic multi-disc clutches to be known as "Igranic-Stromag," under licence from Maschinenfabrik Stromag.

All sizes in the range are available either as dry plate or as lubricated plate types and a further feature is the practicability of remote control from several points. Inherent in the design are a short time response, a high thermal capacity, a low idling torque and compact dimensions. The remarkably short time response is of particular interest to machine tool designers for feed gears and for such special duties as are found in electro-copying machines. This time response can be even further reduced by special circuits or quick-release relays for super-excitation of the magnet.

Financial Section

STOCKS and SHARES

SUBDUED already by anxieties over the Middle East situation, Stock Exchange markets were further sobered by the Chancellor of the Exchequer's statement which preceded the opening of the Trade Union Congress at Brighton. His warning of unfavourable figures to come in the August report on the gold reserves spoilt what had looked to be a promising revival in the gilt-edged market; and industrials were affected by his reminder of the narrow margins upon which the economy continues to be run. The level of stock prices tended to sag, but markets could be commended for standing up reasonably well to a combination of difficult circumstances.

Price Movements

In the electrical equipment market interest has centred mainly upon fluctuations in A.E.I. shares since the final closing date for acceptances of the new shares. After rising by about 6s to 75s in advance of the day, the quotation subsequently slipped back to 71s 3d. Other shares in what the market has come to call the nuclear power group were mostly easier: English Electrics and G.E.C. came back to the common level of 50s and are now showing yields of 5 and over 5½ per cent respectively. Parsons reacted 3s to 93s 3d, and Reyrolles 1s 3d to 113s 9d. Babcock & Wilcox and Clarke Chapmans held on to their previous advances.

Mixed Changes

British Aluminium shares are said to have acquired a considerable transatlantic following on the strength of the company's big Canadian development project, and their price tends to be swung freely by changes in Wall Street's direction. A downward turn there resulted in a drop of 5s in the shares during the past week. On the other hand, Metal Industries were marked up sharply to 20s on news of the sale of the company's investment in Sentinel (Shrewsbury) to Rolls Royce. A reported statement from the chairman recalls the losses sustained by Sentinel in recent years, and the strain of continuing to finance its re-equipment. A. C. Cossor 5s shares were marked down to 5s 3d on the decision to pass the ordinary dividend for the past year. Globe Telegraph new shares went ahead to 5s 6d premium.

Company News

Hackbridge Cable Holdings 5s shares were well supported after the appearance of the full report, which covers this time a full year's trading of the new subsidiaries added to the group during the course of last year. Combined net profits came out at £187,000. The increase of 5 per cent, to 30 per cent, in the Hackbridge Cable dividend for the year has been paid out of the additional profits accrued from the new subsidiaries. These additions to the group have made the title of the parent company misleading, and it is

Price Changes in

Company or Board	Nom. Value	Middle price 3rd Sept.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Gilt-edged Stocks								
Brit. Elec. 1968/73	100	74½x.d.		3	3	4 0 6	80½	74½
Brit. Elec. 1974/77	100	73½	+1	3	3	4 1 9	79⅛	71½
Brit. Elec. 1976/79	100	78½		3½	3½	4 9 3	84	77½
Brit. Elec. 1974/79	100	87½		4¼	4¼	4 17 3	95	88
Overseas Electric Supply								
Calcutta Elec.	£1	20/-		6†	6†	6 0 0†	20/9	19/-
East African Power	£1	19/6		7	7	7 3 6	21/3	19/6
Nigerian Elec.	£1	17/6		10	10*	11 8 6	21/-	17/-
Palestine Elec. "A"	£1	21/-		Nil	Nil	Nil	21/-	21/-
Perak Hydro-Elec	£1	16/-		10	10	—	17/6	14/9
Equipment and Manufacturing								
Aberdare Cables	5/-	12/-	+3d	17½	17½	7 5 9	13/6	10/6
Aerialite	1/-	4/9		88⅛	45*	9 9 6	6/9	4/9
Allen, W. H.	£1	37/6		20	10*	5 6 9	39/-	33/6
Aron Elec. Ord.	£1	55/9		15	15	5 7 6	56/-	53/6
Assd. Automation	10/-	17/6		10	5	2 17 3	19/-	17/-
Assoc. Elec. Ord.	£1	71/3	−3/9	14	15	4 4 3	85/6	57/9
Automatic Tel. & El.	£1	57/6		15	15	5 4 3	72/6	56/3
Babcock & Wilcox	£1	77/6		15	15	3 17 6	85/6	64/-
Baldwin, H. J.	2/-	5/-	+3d	20	20	8 0 0	5/-	3/9
Bakelite	10/-	27/6		16	16	5 16 6	34/-	26/9
Berry's Electric	5/-	6/3		—	10‡	8 0 0	6/6	5/9
British Aluminium	£1	72/6	−5/-	12	12	3 6 3	78/9	40/6
B.I. Callender's	£1	50/-	−6d	10	12½	5 0 0	54/3	45/-
B.I. Callender's 6% Pref.	£1	21/9		6	6	5 10 3	22/6	20/3
British Thermostat	5/-	25/-		20	25	5 0 0	31/9	24/6
British Vac. Cleaner	5/-	7/-		30	15*	10 14 3	8/9	6/-
Brook Motors	10/-	32/6		20	25	7 13 9	44/-	31/9
Brush Group	5/-	6/-		10	10	8 6 9	7/9	5/9
Bulgin, A. F.	1/-	4/9		45	50	—	5/3	4/3
Burco Dean	5/-	8/6		—	22½	13 4 9	13/3	8/3
Chloride El. Storage "A"	£1	63/9		17½	17½	5 9 9	73/6	60/9
Clarke Chapman	£1	120/-		20	22½	3 15 0	123/-	89/6
Cole, E. K.	5/-	17/6		17½	17½	5 0 0	22/3	15/6
Cossor, A. C.	5/-	5/6	−1/6	15	Nil	Nil	10/3	5/3
Crabtree	10/-	26/-		20	20	7 13 9	29/3	26/-
Crompton Parkinson Ord.	5/-	13/3		20	16*	6 0 9	15/-	12/3
De La Rue	5/-	16/9		30	30	8 19 0	20/3	15/-
Decca "A"	4/-	26/9	+6d	56¼	43¾*	6 10 9	44/9	24/9
Desoutter	5/-	31/6		25	30	4 15 3	32/9	25/9
Dewhurst	2/-	6/-		24	30	—	7/6	5/3
Dictograph Tel.	2/-	5/9	+3d	20	20	6 19 3	6/9	5/6
Dubilier Condenser	1/-	4/6		25	30	6 13 3	4/9	3/6
E.M.I.	10/-	27/-	−3d	10	15	5 11 0	37/-	25/6
Electrical Components	5/-	13/9		25	25	9 1 9	16/-	12/6
Elec. Construction	£1	23/9		8½	8½	7 2 3	29/9	23/9
Enfield Cable Ord.	£1	13/9	−6d	Nil	Nil	Nil	19/3	13/6
English Electric	£1	50/-	−1/3	12½	12½	5 0 0	66/3	47/3
English Electric 3¾% Pref.	£1	13/-		3¾	3¾	5 15 6	14/6	12/6
Ericsson Tel.	5/-	38/-		20†	20†	2 12 9†	42/9	33/6
Ever Ready	5/-	27/6	+6d	35	35	6 7 3	32/9	24/-
Falk Stadelmann	£1	36/9		15	17½	9 10 6	45/9	36/9
G.E.C. Ord.	£1	50/-	−1/3	12½	14	5 12 0	65/6	50/-
G.E.C. 6½% Pref.	£1	22/3		6½	6½	5 16 9	23/9	21/3
General Cables	5/-	11/9	+6d	30	30	12 15 3	13/9	11/3
Greenwood & Batley	£1	46/3		17½	17½	7 11 3	47/6	45/-
Hackbridge Cable	5/-	21/9	+6d	25	30	6 18 0	34/6	18/9
Hackbridge & Hewittic	5/-	18/9	+6d	30	23*	6 3 0	22/-	17/3
Heatrae	2/-	3/9		15	15	8 0 0	5/1	3/9
Henley's	10/-	16/9		10½	11½	6 17 3	19/9	14/-
Holophane	5/-	21/-	+6d	25	30	7 2 9	21/-	17/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend forecast.

proposed therefore to change it to Hackbridge Holdings. The chairman (Sir Wavell Wakefield) in his statement says that trading has continued to be satisfactory since the beginning of the current year in April.

At 21s 9d the 5s shares yield a little short of 7 per cent. H. J. Baldwin 2s shares were quoted at 5s to yield 8 per cent, after the company's announcement of increased earnings for the year ended in March, and of the maintenance of the dividend at 20 per cent.

Electrical Investments

Company or Board	Nom. Value	Middle price 3rd Sept.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield % £ s d	1956 Highest	1956 Lowest
Equipment and Manufacturing—continued								
Hoover	5/-	23/6		70	50	10 12 9	39/3	23/-
I.C.I.	£1	44/3	−6d	10	10	4 10 6	49/9	41/3
Intl. Combustion	5/-	19/6	+9d	25	20*	5 2 6	25/-	15/3
Johnson & Phillips	£1	40/9		15	15	7 7 3	46/6	37/6
Lancashire Dynamo	£1	42/6		15	11*	5 3 6	49/9	40/9
Laurence, Scott	5/-	15/9		12½	15	4 15 3	16/9	13/3
Lister, R. A.	£1	30/-	+9d	9·3	10	6 13 3	35/3	27/6
London Elec. Wire	£1	48/3	−6d	12½	12½	5 3 9	52/9	46/5
Lucas, J.	£1	32/6		7½	7½	4 12 3	40/3	29/6
Marryat & Scott	2/-	10/-		30	30	6 0 0	11/3	9/6
Mather & Platt	£1	54/-	+6d	15	15	5 11 0	65/3	51/6
Metal Industries	£1	20/-	+2/6	9	9	—	27/-	16/3
Midlands Elec. Mfg.	£1	45/-		10	12½	5 11 0	48/6	43/6
Morphy-Richards	4/-	20/-		35	50	10 0 0	27/3	20/-
Murex	£1	66/3	−1/3	20	20	6 0 9	70/3	60/-
Newman Ind.	2/-	2/3		10	10	8 17 9	2/9	2/1
Oldham & Son	1/-	2/3		20	17½*	7 15 6	3/-	2/3
Parnall (Yate)	5/-	5/6		14	12	10 18 3	9/6	5/6
Parsons, C. A.	£1	93/3	−3/-	10	10	2 3 0	97/-	61/6
Plessey	10/-	70/3		27½	30‡	4 5 6	87/6	56/-
Pye "A" Deferred	5/-	17/6		12½	12½	3 11 6	21/3	14/-
Reyrolle	£1	113/9	−1/3	15	16½	2 17 3	116/6	81/-
Rheostatic	4/-	9/9		18½	12‡	4 19 0	—	8/3
Richardsons Westgarth	5/-	16/-	+6d	16⅔	16⅔	5 4 3	17/-	13/9
Scottish Cables	4/-	15/9		27½	27½	6 19 3	17/9	15/9
Smith (England), S.	4/-	11/-		17½	17½	6 7 3	14/3	10/6
Southern Areas	£1	17/6		10	7½	8 11 6	28/9	15/-
Strand Elec.	5/-	7/3		17½	15*	10 7 0	8/6	6/9
Sturtevant	5/-	22/9	−3d	14·4†	15†	3 6 0†	31/3	22/6
Sun Elec.	£1	33/9		15	20	11 17 0	37/6	35/-
Switchgear & Cowans	5/-	14/-		20	25	8 18 6	17/-	13/6
Taylor Tunnicliff	5/-	11/9		15	15	6 7 9	14/-	11/3
T.C.C.	10/-	43/-		25	25	5 16 3	45/-	40/6
T.C. & M.	£1	28/-		8½	8½	6 1 6	34/-	26/-
Telephone Mfg.	5/-	7/6		10	10*	6 13 3	8/6	6/3
Thorn Elec.	5/-	17/6		15	15	4 5 9	22/6	16/-
Thornycroft	£1	43/-	+6d	15	15*	6 19 6	49/9	41/3
Tube Investments	£1	60/-	−6d	22½	14*‡	4 13 3	70/6	54/9
Vactric	5/-	12/6	−6d	15	17½*	7 0 0	15/-	11/6
Veritys	5/-	8/-		12½	12½	7 16 3	10/-	6/9
Walsall Conduits	4/-	13/3	+3d	70	20*	6 0 9	13/6	10/9
Ward & Goldstone	5/-	39/3	+6d	30	35	4 9 3	39/6	29/-
Watford	2/-	6/3		25	25	8 0 0	7/6	6/-
Westinghouse	£1	72/6		18	18	4 19 3	100/-	71/6
West, Allen	5/-	12/9	−3d	15	15	5 17 9	14/6	11/6
Wolf Electric	5/-	17/6		20	20	5 14 3	26/3	17/6
Trusts, Transport and Communications								
Anglo-Am. Tel.:								
A. Ord.	100	69½	−1	6	6	8 12 9	80	66
Ord.	100	45½		3⅜	3⅜	8 4 9	54	45
Anglo-Portuguese	£1	21/9		8	8	7 7 0	23/6	20/3
Brit. Elec. Traction:								
Def. Ord. "A"	5/-	19/-	+6d	22½	22½	5 18 6	20/-	15/6
Cable & Wireless:								
Ord.	5/-	10/3	+3d	10	10	4 17 6	11/3	9/6
4½% Loan	100	91		4	4	4 8 0	92½	88
Calcutta Trams	£1	27/3	+1/3	6†	7½†	5 10 0†	27/3	23/-
Cape Elec. Trams	£1	17/6		8	8	8 11 5	20/3	18/-
Marconi Marine	£1	31/-		10	10	6 9 0	34/-	31/-
Oriental Tel. Ord.	1/-	67/6		16	—	—	90/-	67/6
Telephone Rentals	5/-	10/9	+3d	12½	12½	5 16 3	11/9	9/9

Revo and Duport

The offer to shareholders of Revo Electric for an exchange of shares into those of Duport, Ltd., closed last week, and no quotation for the shares is accordingly entered now in the Stock Exchange Official List. Terms of the offer gave three Duport 5s shares for every four Revo 10s shares. The Duport shares issued in exchange, which will not be entitled to the final dividend paid for the year ended in July, are quoted at 18s 6d.

Parmiter, Hope & Sugden

The 1s shares of Parmiter, Hope & Sugden have been quoted at about 3s since the annual meeting at the end of last month, when the chairman referred to improvements of 23 per cent in turnover, and of approximately £50,000 to £70,000 (before tax) in the trading profit, during the year ended in March. Speaking of the current year, he reported that orders received during the first quarter were higher in value than for any previous corresponding period. Dividends totalling 30 per cent have been paid for each of the past three years. On this basis the yield on the shares works out at 10 per cent.

Domestic Appliances

In the market for electrical engineering shares, prices tend to be influenced a good deal by the extent to which a company is concerned with the lighter forms of production as opposed to those coming under the classification of capital equipment. In the former category, the difficulties of the radio industry have become familiar through the periodical returns published by the trade, and through the annual reports of companies involved. The field of home appliances is less well documented, and the interim statement issued recently by Hoover, Ltd., has consequently received wide attention. This left no doubt about the strength of the impact made by the credit restrictions and the high rate of purchase tax imposed by the Government.

Hoover's Statement

The Hoover Company's interim statement informed stockholders that sales had been seriously reduced by the Government restrictions during the first half of this year, turnover at home being 29 per cent below that of the corresponding period of 1955 (although exports were 13 per cent up) and the net profit, before tax, being calculated provisionally at less than half the previous comparable figure of £2·2 million. Prospects for the second six months were said to indicate no appreciable improvement, and conditions were expected to remain difficult for so long as the restrictive measures were maintained. The interim dividend for the current year has however been maintained at 10 per cent, as before.

REPORTS and DIVIDENDS

Parmiter, Hope & Sugden, Ltd.—This company's accounts for 1955-56 were dealt with in our 17th August issue. Speaking at the annual meeting on 29th August the chairman, Mr. Eric Sugden, said that last year turnover had increased by about 23 per cent and the improvement was being maintained. There would be a sharp increase in profits tax this year and costs continued to rise. They felt it to be their duty, and in the long run to their advantage, to do everything possible to stabilise prices.

The directors had had the opportunity of acquiring the whole of the capital of J. F. Collier & Co., Ltd., Macclesfield, which carried out specialist foundry and engineering work. After referring to improved amenities for employees Mr. Sugden said that a large proportion of the company's activities and energies was being devoted to one or two new developments and ventures in designs of switch- and fuse-gear very different from the traditional industrial patterns, and to the development of overseas markets.

Although the Government's anti-inflation measures had caused a reduction in the rate of ordering he did not anticipate that their output would be adversely affected unless that tendency was maintained and intensified.

A. C. Cossor, Ltd.—The preliminary statement for the year ended 31st March last shows a group net loss of £87,445, as compared with a net profit of £254,740 for the preceding year. No ordinary dividend is proposed (against 15 per cent). It is stated that operations were severely affected both by heavy cancellations of Government orders and by the setback to radio and television business caused by the imposition of more onerous hire-purchase terms, etc. The loss for the year includes provision necessary for the writing down of stocks of television and radio sets and components left on hand at the end of the period.

George Cohen Sons & Co., Ltd.—The main figures in the accounts for the year ended 31st March last were given in our issue of 13th July. The full report and accounts now issued include the statement by the chairman and managing director, Mr. C. M. Cohen. In this Mr. Cohen says that the turnover during the year under review of £25 million was some £6 million higher than in the previous year. After dealing with the activities of the various companies in the group, the chairman reviews the outlook and says that for the first few months of the current year the profits are satisfactory, and this also applies to the sum-total of orders booked. Efforts to increase exports have met with an encouraging measure of success, but the engineering industry has already reached the point where margins on external sales are cut to the bone and further price increases are impracticable if we are to stand up to foreign competition, which is becoming increasingly severe. For the current year they have budgeted to make a profit approximately equal to the last. At the annual meeting to be held on 25th September, resolutions will be submitted changing the name of the company to the George Cohen 600 Group, Ltd.

The terms of the issue announced on 23rd August have now been fixed. It is proposed to issue, by means of a placing, £1,500,000 6 per cent unsecured loan stock 1975/80 at par. The brokers are Cazenove & Co.

Pye, Ltd.—The accounts of this company for 1955-56 were summarised in our issue of 3rd August. In his annual review the chairman (Mr. C. O. Stanley) said that the company's profit margin had been considerably reduced by the directors' decision not to raise prices to cover the increase in purchase tax on radio and television sets. It was their policy to endeavour to stabilise present prices and to devote a greater part of their efforts to consolidating the company's hold on world markets. This would result in a reduction of profit to some degree.

Rangoon Electric Tramways & Supply Co., Ltd.—There was a loss of £17,419 for the year ended 30th September, 1955, as compared with a loss of £13,732 for the preceding year. The preference dividend is paid for the six months to 31st December, 1954, and £79,385 is carried forward against £104,304 brought in. The directors expect to receive an official communication in the near future regarding the valuation of the company's assets for take-over purposes.

H. J. Baldwin & Co., Ltd., report that group trading profits for the year to 31st March last were £123,988 as compared with £71,819 for 1954-55. The profit attributable to the parent company was £36,930 (£24,282) after deductions, including tax. The final ordinary dividend is 10 per cent, maintaining the year's distribution at 20 per cent.

The Chloride Electrical Storage Co., Ltd., has declared an interim dividend of 5 per cent on the "A" and "B" ordinary stock (same).

Walsall Conduits, Ltd., is maintaining its interim dividend at 7½ per cent.

Brown Bros., Ltd.—In declaring an interim dividend of 2½ per cent (same but on increased capital) the directors say that this should not be taken as an indication that the year's distribution will be greater than that for 1955.

New Companies

Chethill, Ltd.—Registered 7th August. Capital £1,000. Electrical contractors, manufacturers of and dealers in electrical goods and apparatus, etc. Directors: R. A. Underhill and J. P. Chettle. Regd. office: 7, Oxford Road, Manchester.

Vaclight Distributors, Ltd.—Registered 2nd August. Capital £100. Importers, exporters, assemblers of and dealers in electrical goods of all kinds, etc. Directors: B. H. Lewis and J. Pachter. Regd. office: 59-61, Borough High Street, S.E.1.

Cupolar Engineering Co., Ltd.—Registered 24th August. Capital £1,000. Retailers, wholesalers, manufacturers and repairers of and dealers in dynamos, motors, armatures, magnetos, etc. First directors: E. W. T. Bason and Mrs. Ivy P. Bason. Solicitors: S. R. Pinks and Co., 1, Francis Grove, Wimbledon, S.W.19.

Wentworth Electronics (Chertsey), Ltd.—Registered 16th August. Capital £100. Electrical, radio, television, public address and recording engineers, etc. Directors: I. A. B. Brampton (governing director) and Maureen B. Brampton, and J. H. Theakston, directors of Wentworth Electronics Co., Ltd. Sec.: Maureen B. Brampton. Regd. office: 9, Windsor Street, Chertsey, Surrey.

D. P. Controls, Ltd.—Registered 17th July. Capital £2,000. Manufacturers of electronic, electrical and mechanical control equipment and machinery, etc. Directors: G. V. Carr, W. H. Jardine, Elspeth Carr and S. C. Proudfoot. Solicitors: Anderson & Haggie, Newcastle-on-Tyne, 1.

Kaye & Nicholls (Floxton), Ltd.—Registered 8th August. Capital £1,000. Electrical engineers, etc. Directors: A. Kaye, J. C. Kaye and E. Nicholls. Regd. office: Headlands, Floxton, near Wakefield.

Increases of Capital

British Insulated Callender's Cables, Ltd.—Increased by £4,500,000, in £1 ordinary shares, beyond the registered capital of £17,500,000.

Wilkins & Mitchell, Ltd.—Increased by £500,000, in £1 ordinary shares, beyond the registered capital of £500,000.

Transformer Development Laboratories, Ltd.—Increased by £1,700, in £1 shares, beyond the registered capital of £300.

Martindale Electric Co., Ltd.—Increased by £49,800, in £1 ordinary shares, beyond the registered capital of £200.

Bull & Lott, Ltd.—Increased by £900, in £1 ordinary shares, beyond the registered capital of £100.

Oxley Developments Co., Ltd.—Increased by £5,000, in £1 ordinary shares, beyond the registered capital of £5,000.

Liquidations

C. Drewery (Electrical), Ltd.—Winding up voluntarily. Liquidator, Mr. S. D. Moore, 4, Silver Street, Hull, appointed 20th August.

Alexander Electrical Co., Ltd.—Winding up voluntarily. Particulars of claims to the liquidator, Mr. F. S. Young, 5, Mansfield Street, London, W.1, by 1st October.

Modern Electrical Industries (Export), Ltd.—Members' voluntary winding-up. Meeting of members 27th September, at Hollingworth Lane, Knottingley, to hear an account of the winding-up by the liquidator, Mr. E. O'Neill.

West Wales Electric, Ltd.—Meetings of members and creditors on 28th September at Liverpool House, Penlan Street, Pwllheli, to hear an account of the winding-up by the liquidator, Mr. B. Smith.

Bankruptcies

F. Simons, electrical contractor, 15, The Council House, Winchcombe Road, Setgeberrow, Evesham, Worcs.—Last day for receiving proofs for dividend 14th September. Trustee, Mr. R. F. Bendall, 126, Colmore Row, Birmingham, 3.

S. R. L. Sutton, carrying on business as an electrical dealer at 127, Sultan Road, Portsmouth, as Sutton & Sons (described in the Receiving Order as S. Sutton & Sons).—Public examination 5th November at the County Court, Ashburton Road, Kent Road, Portsmouth.

Street Lighting

IMPROVED lighting is no substitute for care and thought by all road users, but "wisely used in conjunction with these characteristics it can play an extremely valuable part in making our highways safer." This opinion is expressed by Mr. John Pate, chairman of the SHEFFIELD Watch Committee, in a foreword to the 1955-56 annual report of the lighting engineer (Mr. C. J. Chisholm). A point of importance to which he draws attention is that statistics recently placed before the City Council have shown that there are fewer accidents where sodium lighting has been installed. The Council proposes to relight the centre of the city and trial fluorescent fittings have been installed in Angel Street and at the Pond Street Bus Station. The lighting engineer says that the first task is to re-light the remaining Class "A" roads where the illumination is below the recommended standard and he hopes this work will be carried out during 1956-57. Residential streets should also be well lit. The number of lamps in service at the end of March last was 30,713 (electric 19,245; gas 11,468).

A new lighting system costing approximately £9,600 has now been installed in KINGSWOOD, near Bristol, where 122 fluorescent lanterns have been supplied and erected by the General Electric Co., Ltd., to replace the previous gas lighting. The newly lit streets include a section of road on the main artery to Chippenham, Marlborough, Newbury, Reading and London. The installation consists of 43 G.E.C. Z.8381 "Three-Eighty" lanterns, each having three 80 W "Osram" "warm white" fluorescent tubes; 29 Z.8281 "Two-Eighty" lanterns, housing two 80 W tubes; and 50 Z.8247 "Two-Forty" "Perspex" refractor lanterns, housing two 2ft 40 W tubes. Most of the "Three-Eighty" and "Two-Eighty" lanterns are mounted on Concrete Utilities 3D concrete columns and some of the "Two-Forty" lanterns are mounted on "Broadcrete 500" columns with special brackets. Others are on metal brackets fixed to existing South Western Electricity Board poles carrying overhead mains.

A table in the 1955-56 report of Mr. C. C. Smith, M.I.E.E., F.I.E.S., the city lighting engineer of LIVERPOOL, shows the progress of street lighting conversion since the war. In 1939 there were 386 miles of streets and passages with electric lighting and 567 miles with gas lighting, whereas the figures are now 560 and 375 miles respectively. Before the war there were 17,989 electric and 15,181 gas lamps in service; the present totals are 25,257 and 10,755. In the year ended 31st March last electricity charges amounted to £48,610 for 10·6 million kWh, equal to 1·102d/kWh. Gas consumed cost £41,435. The Department is now working on the second stage of its lighting conversion scheme. The complete programme is expected to cost some £600,000 over a period of ten to fifteen years.

NEWCASTLE-ON-TYNE City Council is being recommended to commence work on Stage 2 of its scheme for converting 10,000 street gas lamps to electric lighting. The first stage, costing £37,000, was sanctioned a year ago, and is now well in hand. The second stage, which will involve about 1,250 lamps, will cost £47,000. The whole scheme is being spread over ten years.

In our 17th August issue we reported the switching on of the first of the new lighting units in Eastern Avenue, Romford. A night picture of the first section, which uses Thorn "Atlas Alpha One" sodium lanterns, is shown in the accompanying illustration.

Eastern Avenue, Romford, where sodium lamps were switched on recently by the Mayor of Romford

ECCLES Corporation is to seek sanction to borrow £8,000 for street lighting in Green Lane, Canal Bank, Rocky Lane, Monton Green and Clifton Road.

AMPTHILL (Beds) U.D.C. has approved a scheme, estimated to cost £1,781, for the installation of fluorescent street lighting on roads near the town centre.

WANSTEAD and WOODFORD Corporation reports that a scheme, estimated to cost £12,275, is being prepared for the conversion from gas to electricity of the street lighting along trunk road T.2.

To improve the lighting of Leeds and Bradford Road, and Hunslet Road, York Road By-pass, LEEDS City Council is recommended to apply for sanction to borrow £15,265.

CATALOGUES AND LISTS

BATTERIES.—24-page catalogue ("B") giving full details of Exide-Ironclad and Exide heavy duty batteries for use in buses and coaches.—**Chloride Batteries, Ltd.,** Exide Works, Clifton Junction, Swinton, Manchester.

CABLES.—Stock list detailing the range of industrial cables available from the company.—**E. M. Tatton & Co., Ltd.,** Kew Bridge, Brentford.

Folder containing descriptive leaflets dealing with cables produced by the company, including microphone cables, high frequency cables and television downleads. Other leaflets deal with the range of "Permathene" wiring cables and "Permanoid" insulating sleevings and binding twine.—**Permanoid, Ltd.,** New Islington, Manchester, 4.

CABLE TRUNKING.—Brochure (T3/56) describing the company's range of cable trunking and accessories, including skirting trunking, flush-in-floor and underfloor mounting types.—**Davis Sheet Metal Engineering Co., Ltd.,** Eley's Estate, Angel Road, Edmonton, London, N.18.

CURRENT TRANSFORMERS.—8-page catalogue (SG/335) describing the company's range of standard current transformers for use on equipment up to 15 kV and giving a brief theory of current transformers.—**English Electric Co., Ltd.,** Switchgear Department, Liverpool.

ELECTRIC MOTORS.—Illustrated booklet dealing with motors manufactured by the company for incorporation in machine tools.—**Lancashire Dynamo & Crypto, Ltd.,** Trafford Park, Manchester, 17.

INSTRUMENTS.—Leaflet describing the company's impregnation recording equipment, and an illustrated leaflet on the company's cable eccentricity gauge.—**Addison Electric Co., Ltd.,** 10/12, Bosworth Road, London, W.10.

TRANSFORMERS.—Three leaflets describing respectively mining type, "U" type neon, and standard ignition transformers.—**Foster Transformers, Ltd.,** South Wimbledon, London, S.W.19.

VACUUM PUMPS.—Descriptive folder dealing with high vacuum rotary piston pumps with gas ballast for pumping vapour containing gases.—**N.G.N. Electrical, Ltd.,** Cawdor Street, Patricroft, Manchester.

WELDING EQUIPMENT. — Leaflet (WA/134) describing "fillerees" electrodes which have been developed for filling cavities in steel castings.—**English Electric Co., Ltd.,** Welding Electrode Division, Clayton-le-Moors, Accrington.

13-page catalogue illustrating and describing a selection of the company's standard types of welding machines.—**Sciaky Electric Welding Machines, Ltd.,** Farnham Road, Slough, Bucks.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 12th September from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1952

8353. Chromatic Television Laboratories, Inc.—Colour television receivers. 2nd April, 1952. (757071.)

12404. Brown, R.—Operating circuits for electric discharge lamps. 13th February, 1950. (757080.)

24226. Telefonaktiebolaget L. M. Ericsson. —Electric circuits comprising gas-filled glow-discharge tubes. 26th September, 1952. (757022.)

27698. Libbey-Owens-Ford Glass Co.—Electrically conductive article. 4th November, 1952. (757072.)

28801. General Electric Co.—Electric ignition apparatus. 14th November, 1952. (756926.)

1953

5897. General Electric Co., Ltd., and Jenkins, H. G.—Electroluminescent devices. 3rd March, 1954. (756932.)

10212. Metropolitan-Vickers Electrical Co., Ltd.—Pulse generators. 14th April, 1954. (756938.)

11832. British Thomson-Houston Co., Ltd.—Control circuits for electric generators. 14th April, 1954. (756855.)

12913. Standard Telephones & Cables, Ltd.—Tuner for tuning a circuit over two different frequency ranges. 8th May, 1953. (756940.) 12914. Radio frequency tuner. 8th May, 1953. (756941.)

15194. General Electric Co.—Vulcanisation of silicone rubber. 1st June, 1953. (757024.)

15969. Parsonage, S. H.—Thermally operated electric switches. 9th September, 1954. (756858.)

16473. Telephone Manufacturing Co., Ltd.—Automatic telephone exchange systems. 10th June, 1954. (757025.)

17630. Fisher, A. A.—Electric heating of fluids. 25th June, 1954. (756945.)

19180. Dorman & Smith, Ltd.—Automatic electric circuit-breakers. 18th June, 1954. (757088.)

20371. General Electric Co., Ltd., and Hill, R. T. J.—Manufacture of screens for cathode-ray tubes. 20th July, 1954. (757092.)

20668. National Research Development Corporation.—Transistor circuits. 25th October, 1954. (757027.)

22709. Electric & Musical Industries, Ltd. —Amplifying circuits having automatic gain control especially for picture signals in television receivers. 9th August, 1954. (756951.)

22915. Taylor, F. M. H.—Control apparatus for electric motors. 16th August, 1954. (757029.)

23567. Karantha, K. V.—Composite electric insulators. 26th August, 1953. (756866.)

24773. Electric & Musical Industries, Ltd. —Detector circuits for amplitude modulated carrier waves. 27th August, 1954. (756746.)

25816. Standard Telephones & Cables, Ltd.—Tracking adjustment for u.h.f. circuits. 18th September, 1953. (756953.)

26697. Record Electrical Co., Ltd.—Electrical measuring instruments of the moving coil type. 27th September, 1954. (757033.)

28527. Murphy Radio, Ltd.—Focusing means for cathode-ray tubes. 15th October, 1954. (757100.)

28620. Brown, Boveri & Co., Ltd.—Magnetic induction accelerators. 16th October, 1953. (756872.)

28764. Cables & Plastics, Ltd.—Sealing glands for electric cables. 14th October, 1954. (756747.)

29168. Chloride Electrical Storage Co., Ltd.—Separators for use in electric accumulators. 26th October, 1954. (757102.)

32647. Goebel, F., Stocke, E., and Stocke, R.—Electrically heated furnaces. 23rd November, 1954. (756753.)

35781. General Electric Co.—Refrigerators and like storage cabinets. 23rd December, 1953. (756970.)

36046. Klein, S.—Electric transducers. 29th December, 1953. (757111.)

1954

2631. Manganese Bronze & Brass Co., Ltd.—Copper-base electrical resistance alloys. 29th December, 1954. (756884.)

2816. British Thomson-Houston Co., Ltd. —Cavity resonators. 31st January, 1955. (757040.)

2824. Carr Fastener Co., Ltd.—Electrical components and means for mounting these on a panel or support. 16th November, 1954. (757114.)

2831. Enfield Cables, Ltd.—Protective coverings for electric cables and similar articles. 15th April, 1955. (756885.)

3073. Lyle, W. W.—Multi-position electric switch. 2nd May, 1955. (756886.)

4547. British Thomson-Houston Co., Ltd. —Automatic control of air locks in mines. 11th February, 1955. (756887.)

5105. Deventer, H. R. Van.—Means for controlling telephone answering devices. 22nd February, 1954. (756759.)

5177. Air Preheater Corporation.—Precipitator flashover control through current and voltage response. 22nd February, 1954. (756760.)

6495. Igranic Electric Co., Ltd.—Protective systems for d.c. motors. 5th March, 1954. (756980.)

7432. Igranic Electric Co., Ltd., and Taylor, J. R.—Electro-magnetic clutches. 15th March, 1955. (756983.)

7647. Allis-Chalmers Manufacturing Co. —Pressure responsive anti-pumping control system for electric circuit-breakers. 16th March, 1954. (757123.)

8807. Mechanical Products, Inc.—Electric circuit-breakers. 25th March, 1954. (756764.)

8967. Macchioni, P. A., and Macchioni, L.—Electric hammer. 26th March, 1954. (756988.)

9003. Automatic Telephone & Electric Co., Ltd.—Translating circuits. 2nd February, 1955. (757049.)

9577. Kellendorfer, R., Skambraks, S., and Strasser, E.—Conducting-liquid electric circuit interrupters. 1st April, 1954. (756766.)

9805. Compagnie Générale de Télégraphie sans Fil.—Emissive cathodes. 2nd April, 1954. (756767.)

10180. Conductores Electricos Roque Soc. Anon.—Method of covering electrical conductors with insulation, and means for carrying the method into effect. 7th April, 1954. (756768.)

10880. Henley's Telegraph Works Co., Ltd., W. T., and Hubbard, H.—Means for effecting electrical bonds. 13th April, 1954. (756775.)

11022. Scarpa, G.—Electrostatic stress distribution arrangements in high voltage transformers. 14th April, 1954. (757130.)

11897. Automatic Telephone & Electric Co., Ltd.—Switching mechanisms for use in telephone or like systems. 18th February, 1955. (757132.)

12121. Licentia Patent-Verwaltungs-Ges. —Telephone system with satellite exchanges or similar electric systems. 27th April, 1954. (757051.)

12592. English Electric Co., Ltd.—Series trip coils for electric circuit-breakers. 29th April, 1955. (756780.)

12597. English Electric Co., Ltd.—Electric switchgear. 29th April, 1955. (756781.)

13857. Heron, A. G.—Flexible electric heating hoses. 10th May, 1955. (756787.)

13999. Telefunken Ges.—High frequency electrical circuits. 13th May, 1954. (757052.)

14402. Boart Products South Africa, Ltd. —Electric supply system for electrolytic grinding. 17th May, 1954. (757143.)

15734. Philips Electrical Industries, Ltd. —Carrier-telegraph systems. 27th May, 1954. (757145.)

16639. Telemecanique Eléctrique.—Electrical circuit-breaker apparatus carried on movable frames. 4th June, 1954. (756995.)

17587. M.K. Electric, Ltd., Arnold, C. L., Dowsett, R. W., and Sharman, A. V.—Electric tumbler switches. 9th May, 1955. (756795.)

18831. Bauer, R. E.—Activation of electric dry batteries. 28th June, 1954. (756998.)

20373. Naimer, H.—Cam-operated electric switch. 12th July, 1954. (756804.)

20656. Tagliaferri, A.—Electric induction furnaces. 15th July, 1954. (757152.)

20933. Marconi's Wireless Telegraph Co., Ltd.—Radar systems. 9th May, 1955. (756805.)

21593. General Electric Co.—Centrifugal electric switch mechanisms. 23rd July, 1954. (757156.)

22497. Philips Electrical Industries, Ltd. —Annular magnetic heads for recording, reproducing or erasing magnetic records. 3rd August, 1954. (757158.)

23618. Latorre, A. M.—Electric generators. 13th August, 1954. (756806.)

24024. Officine Galileo Soc. Per Azioni. —Magnetic or electro-magnetic operated ratchet device particularly used as an irreversible device for small synchronous motors of the so-called reaction type and the like. 18th August, 1954. (756807.)

25422. Bendix Aviation Corporation.—Electric power supply systems. 1st September, 1954. (756810.)

25444. Hoover, Ltd. (Hoover Co.).—Food mixers. 1st September, 1954. (757168.)

25457. Bosch Ges., R.—Screened electric ignition systems. 2nd September, 1954. (756811.)

28343. Western Electric Co., Inc.—Coaxial electric switches and relays. 1st October, 1954. (756817.)

30705. Bendix Aviation Corporation.—Plunger type electro-magnetic pumps. 25th October, 1954. (756905.)

33292. Philips Electrical Industries, Ltd. —Crystal-controlled oscillators. 17th November, 1954. (757063.)

33407. Norddeutsche Seekabelwerke Akt.-Ges.—Water-tight plug arrangement for electric cables. 18th November, 1954. (756909.)

33668. Chromatic Television Laboratories, Inc.—Cathode-ray tubes. 2nd April, 1952. (757193.)

33763. Stichting voor Fundamenteel Onderzoek der Materie.—Process of nuclear fission. 22nd November, 1954. (757015.)

33951. Millet, R.—Rotating-field electric machines. 23rd November, 1954. (756831.)

34971. Metropolitan-Vickers Electrical Co., Ltd.—H.v. electric supply circuits. 2nd December, 1954. (756832.)

35417. Mullard Radio Valve Co., Ltd.—Electric switch contact devices and quartz fibre electrometers including such devices. 7th December, 1954. (756912.)

36341. Rheostatic Co., Ltd.—Thermostats, switches and energy regulators. 15th December, 1954. (757197.)

37116. Philips Electrical Industries, Ltd. —Cylindrical dispenser cathodes. 22nd December, 1954. (757066.)

37824. Siemens & Halske Akt.-Ges.—Aerial systems. 31st December, 1954. (756838.)

1955

7224. National Research Development Corporation.—Radar display system. 20th September, 1954. (757019.)

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia. — 20th September. Snowy Mountains Hydro-Electric Authority. Voice frequency signalling transmitters and receivers, etc. (E.S.B. 21881/56. Ten/21125.)*

2nd October. Department of Public Works, New South Wales. Vertical centrifugal pumps directly coupled to squirrel cage motors for sewage and sludge pumping. (E.S.B. 21882/56. Ten/21116.)*

14th November. State Electricity Commission of Victoria. Power transformers for metropolitan terminal stations. (E.S.B. 21523/56. Ten/21112.)*

Belgian Congo.—19th September. Ministry of Colonies, Brussels. 590 kVA hydro-electric generating unit. (E.S.B. 21392/56. Ten/21062.)*

Birmingham.—24th September. Birmingham Tame and Rea District Drainage Board. Mechanical and electrical equipment for the sewage purification works at Norton Green, near Knowle. R. Vincent Davies, engineer to the Board, Rookery Park, Erdington, Birmingham, 24.

Burma.—24th September. Union Purchase Board, Rangoon. Lampholders and lighting fittings. (E.S.B. 21620/56. Ten/21054.)* 26th September. 625 electric fans. (E.S.B. 21955/56. Ten/21099.)* V.i.r. wire and cable. (E.S.B. 21957/56. Ten/21100.)*

Canada.—18th September. St. Lawrence Seaway Authority. Electric motors and limit switches for operation of sector and mitre gates, etc. (E.S.B. 21727-8/56. Ten/21095-6.)*

Formosa.—20th September. Central Trust of China. Mining cable and trucks, etc. (E.S.B. 21294/56. I.C.A. Ten/20976.)* 26th September. Power cables, potheads, joint boxes, switchgear and test meters. (E.S.B. 21987/56.I.C.A Ten/21111.)*

French West Africa.—Radio transmission station. Requests for authorisation to tender to the Directeur des Travaux Publics du Senegal, Saint-Louis, not later than 12th September. (E.S.B. 21475/56. Ten/21049.)*

India.—28th September. Madras Port Trust. Forty floodlight units. 5th October. Cables. (E.S.B. 21797/56. Ten/21063.)*

27th September. Madhya Pradesh Electricity Board. 1,500 kW diesel alternator set and ancillary equipment for Korba power station. (E.S.B. 21371/56. Ten/20959.)*

5th October. India Supply Mission, Washington. 526 portable magnetic tape recorders and 541 public address sets. (E.S.B. 20955/56. I.C.A. Ten/20921.)*

17th October. Engineer-in-Chief, Eastern Railway, Calcutta. 3,000 V d.c. overhead traction equipment for electrification of the Howrah-Burdwan Chord, Sealdah Suburban, Burdwan-Asansol and Howrah-Khargpur sections. (E.S.B. 20780/56. Ten/21014.)*

Iraq.—15th October. Ministry of Development. Steel-cored aluminium cable for 300 km of double-circuit power transmission lines, mainly 132 kV, for Northern Iraq electrical system. (E.S.B. 21432/56. Ten/20981.)*

Longbenton.—24th September. U.D.C. Street lighting equipment. (See this issue.)

Manchester.—3rd October. Waterworks Committee. Cable. (See this issue.)

Newtown and Llanllwchaiarn. — 12th October. U.D.C. Street lighting equipment. (See this issue.)

New Zealand.—5th October. Dunedin City Corporation. Regulators. (E.S.B. 22317/56. Ten/21169.)* 150 kVA, 33 kV/400 V transformer. (E.S.B. 22316/56. Ten/21147.)*

5th October. Stores Division, G.P.O., Wellington. Telephone cable. (E.S.B. 22311/56. Ten/21149.)* 24th October. Radio test equipment. (E.S.B. 22314/56. Ten/21144.)*

Northern Ireland. — 19th September. Board of Governors. Electrical installation in the girls' intermediate school, Ardglass Road, Downpatrick. Varming & Mulcahy, consulting engineers, 37, Malone Road, Belfast.

Norwich.—29th October. City Council. Pumps, electric motors, starters and switchgear, wiring, cabling, etc., for the Trowse pumping station reconstruction scheme. H. C. Rowley, city engineer, City Hall.

Rhodesia and Nyasaland.—19th September. City of Bulawayo. Boiler house lifts. (E.S.B. 21941/56. Ten/21086.)*

Sedgefield (Durham).—R.D.C. Electrical installation in 54 houses at West Cornforth. Housing architect, Council Offices, Sedgefield.

South Africa.—21st September. Stores Department, S.A. Railways. Cable end boxes. (E.S.B. 21822/56. Ten/21064.)* P.v.c. cable and copper cable. (E.S.B. 21837/56. Ten/21087.)* 26th September. Overhead track equipment and fittings. (E.S.B. 21991 and 21993/56. Ten/21121 and 21119.)* 28th September. 49 roof fans. (E.S.B. 21992/56. Ten/21113.)*

South West Africa.—14th September. Tender Board. Screwed steel electric conduit. (E.S.B. 21870/56. Ten/21191.)*

Spain.—17th September. Hidroelectrica Espanola, S.A., Madrid. Electrical equipment. (E.S.B. 21774/56. I.C.A. Ten/21041.)*

Instituto Nacional de Industria, Plaza de Salamanca 8, Madrid. Circuit-breakers with transformers (150 kV, 3,500 MVA) and lightning rods. (E.S.B. 21087/56. I.C.A. Ten/20939.)*

Stafford.—25th September. Corporation. Street lighting equipment. (See this issue.)

Stamford.—1st October. Borough Council. Street lighting equipment. (See this issue.)

West Lancashire.—24th September. Rural District Council. Concrete-steel columns and brackets, discharge lamps and lanterns, etc., for trunk road lighting. (See this issue.)

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Arbroath.—Corporation. Electrical work in connection with 56 permanent houses at Montrose Road (£3,382).—J. Campbell.

Watford.—Housing Committee. Recommended. Electrical installations in 495 houses to be erected on the Meriden estate (£14,382).—J. F. Hillman.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Airdrie.—Police headquarters in Anderson Street (£60,000); burgh surveyor.

Aldridge.—Primary school at Red House Lane, and first phase of county secondary school at Pheasey; director of education, Green Hall, Lichfield Road, Stafford.

Altrincham. — Crematorium, office block, house, etc., Whitehouse Lane, Dunham Massey, for the Altrincham, Bowdon, Hale and District Joint Cemetery Board; H. V. Shaw, engineer to the Board, Dunham Mount, Dunham Road, Altrincham.

Amesbury.—Houses (34); Bothams & Brown, architects, 32, Chipper Lane, Salisbury.

Arbroath.—Houses (56), Montrose Road; burgh surveyor.

Ashby.—Houses (115); U.D.C. architect, Ashby, Leics.

Audenshaw.—Administrative block at Shepley Works; The Autodrome, Ltd., automobile engineers, Gaythorpe Road, Manchester.

Barnstaple.—Factory, Braunton Road; Jantzen, Ltd., Great West Road, Brentford.

Barrow-in-Furness. — Textile factory in Park Road; Sir Elkanah Armitage & Sons, Ltd., Hole House Mill, Blackburn.

Barry.—College of further education at Colcut Road; county architect, Glamorgan County Hall, Cardiff.

Bath.—Flats (24), Norfolk Crescent; city architect.

Technical college, Avon Street and Milk Street; Frederick Gibberd, 8, Percy Street, London, W.1.

Blyth.—Houses (51), Patterdale Road and Delaval Terrace; D. W. Foster, borough engineer.

Boldon (Co. Durham).—Houses (26), West Boldon, for U.D.C.; J. T. Edmondson, surveyor, East Boldon.

Bracknell.—New headquarters for Meteorological Office; Ministry of Works Architects' Department, Abell House, John Islip Street, London, S.W.1.

Brentford & Chiswick.—Flats and maisonnettes (125) and shops (21) on site off High Street; W. F. Church, town clerk, Town Hall, Chiswick, W.4.

Bridlington.—Secondary school at Sewerby Heads; county architect, County Hall, Beverley.

Bristol.—Seven-storey offices and showrooms in Baldwin Street (£250,000), for the Equity and Law Life Assurance Society, 20, Lincoln's Inn Fields, London, W.C.2; George Brown & Partners, architects, Brunel House, Bristol, 1.

Carnforth.—County secondary school; Tom Mellor, architect, Old Market Hall, Lytham St. Annes.

Cheadle.—Dwellings (225), Outwood Road; T. Costello, Ltd., 45, Clifton Road, Heaton Moor, Stockport.

Coleford.—Houses (28), Highbury area; Humphrey H. Goldsmith, architect, 18, Gay Street, Bath.

Coleshill.—Houses (58), Stonebridge Road, for Meriden R.D.C.; surveyor, The Old Vicarage, Coleshill.

Consett.—Secondary modern school at Moorside; Newrick & Blackbell, architects, 58, John Street, Sunderland.

Crawley.—Canteen and garage block and extensions to administration block at sewage works, Radford Road, Tinsley Green, for Development Corporation; chief architect, Broadfield, Crawley, Sussex.

Cumberland. — Additions to Thursby Primary School; county architect, 15, Portland Square, Carlisle.

Darlington.—Factory additions, West Auckland Road, for Chemical and Insulating Co., Ltd.; J. W. Richardson and Son, builders, Quebec Street.

Arcade of 10 shops at Skinnergate for W. Haithwaite; N. H. Godsmark, architect, 37a, Tubwell Row.

Deal.—Flats and maisonnettes (30), St. Martin's Road; S. C. Ward, Ltd., builders, 37a, Newington Road, Ramsgate.

Dudley. — Houses (310), Russells Hall estate; borough architect.

Easington.—Houses (50) at Horden; R. L. Lumsden, R.D.C. surveyor.

Ealing.—Flats (36), Fairview estate; Bury Building Co., Ltd., Cannonbridge House, Bury Street, Ruislip.

Eastbourne.—New concert hall and conference hall, Devonshire Park, for T.C.; Westwood, Sons and Harrison, architects, 46, Baker Street, London, W.1.

East Ham.—Houses (200) as development of 14½-acre site at Stanford-le-Hope; chief housing officer, Town Hall, E.6.

East Retford.—Houses (52), West Hill estate; Vallance, Westwick & Associates, architects to T.C., White Hart Chambers, Mansfield.

Eccles.—Flats, Barton Lane; Frank Bradley, architect, 4, Wood Street, Bolton.

Gateshead.—Factory, Team Valley trading estate, for Huwood Mining Machinery Co., Ltd.; L. J. Couves & Partners, architects, Carliol House, Newcastle-on-Tyne.

Gatwick.—New terminal buildings proposed at the Airport, for B.O.A.C.; Yorke, Rosenberg & Mardall, architects, 2, Hyde Park Place, London, W.2.

Gerrards Cross.—Houses (100); A. E. A. Prowting, Ltd., 127, High Street, Ruislip.

Glasgow.—Factory at North Cardonald for Ever Ready Razor Products; Scottish Industrial Estates, Ltd., 3, Woodside Place, Glasgow, C.3.

Gosforth.—Primary, infants' and junior school (£96,000), and primary school (£54,000); C. C. Brown, Northumberland county architect, County Hall, Newcastle-on-Tyne.

Guernsey.—Secondary modern school at Beaucamp, Castel; States Engineer, States Office Annexe, Albert Pier, Guernsey.

Guildford.—Project for redevelopment of portion of Upper High Street with commercial buildings; borough surveyor, Municipal Offices, High Street.

Halesowen.—Extensions to factory and offices, Coombes Road; Robert Hipkiss, Ltd., engineers, Coombes Road.

Hartlepool.—Houses (47) in Blandford Street West; borough engineer.

Hereford.—Wholesale warehouse on the Berrington Street/Little Berrington Street site; W. H. Smith & Son, Ltd., Strand House, Portugal Street, London, W.C.2.

Hertford.—Flats (57), Sere Farm estate; Compton Bros., Ltd., builders, 185-9, Beaconsfield Road, Enfield.

Hollingbourn.—Houses (150), Vintners Park; Lawrence Farman & Partners, 1, Middle Row, Maidstone.

Houghton-le-Spring.—Factory additions for N. Hyer, Ltd., clothing manufacturers; Mauchlen, Weightman & Elphick, architects, 12, Saville Row, Newcastle-on-Tyne.

Jarrow.—Blocks of flats, Queen's Road; borough engineer.

Lichfield. — Secondary modern school, Borrowcop Lane; F. & E. V. Linford, Ltd., builders, Park Road, Cannock.

Llangefni.—First stage of College of Further Education; county architect, Shire Hall.

London.—Scheme for redevelopment of Victoria Station area, including 10-storey and 7-storey offices and 17-storey hotel; T. P. H. and E. Braddock, architects to promoters, 14, Great Smith Street, S.W.1.

College for General Practitioners, Lincoln's Inn Fields; Trehearne & Norman, Preston & Partners, 83, Kingsway, W.C.2.

Office block, West Ham; London Co-operative Society, Ltd., Gladding Road, E.12.

Lowestoft.—Houses (136), Beeches estate; borough surveyor.

Maidstone.—Flats (108), Shepway estate; H. Richardson & Co., Ltd., Slades Green Road, Crayford.

Manchester.—Radio studios, offices, stores, workshops, etc., on four-acre site at Platt Fields Park, Rusholme, for new North Region headquarters; British Broadcasting Corporation, Portland Place, London, W.1.

Mere and Tisbury.—Houses (26), Mere; Bothams & Brown, architects, 32, Chipper Lane, Salisbury.

Mitcham.—Printing factory for Hancock, Corfield & Waller, Ltd., Trafalgar Works, Station Road, London, S.W.19; George Lee, quantity surveyor, 88, Gray's Inn Road, Holborn, London, W.C.1.

Newcastle-on-Tyne.—Joinery works and offices, Fisher Street, for Universal Joinery Works, Ltd.; Alston Limestone Co., Ltd., contractors, Blackett Street.

Newton Aycliffe.—Houses (142) for Aycliffe Development Corporation; G. A. Goldstraw, chief architect.

North Shields.—Factory at West Chirton for Stella Building Products, Ltd.; H. Gatoff, architect, 51, Grainger Street, Newcastle-on-Tyne.

Nottingham.—Houses (482) and flats (182), Glapton estate; city housing architect.

Pembroke.—Dwellings (52), Hawkestone Road; Gibson & King, Ltd., builders, Great North Road, Milford Haven.

Penrith.—Houses (40) on the Scaws estate for the U.D.C.; John Kitchen, builder, Lowther Terrace.

Peterborough.—Houses (280), on Blue Bell estate, Dogsthorpe; L. H. Robjohn, city surveyor, Town Hall.

Petworth. — Secondary modern school (£141,055); F. R. Steele, county architect, County Hall, Chichester.

Portsmouth.—Flats (30), Allaway Road and (15) at Hambrook Street; A. G. Figgins, Ltd., Little Park estate, Bedhampton.

Redditch.—Primary school, Studley Road; J. & A. Brazier, Ltd., 170, Worcester Road, Bromsgrove.

Seaham.—Houses (102) on the Denehouse Road estate for the U.D.C.; L. W. Evans, Ltd., builders, Norfolk Street, Sunderland.

Shrewsbury.—Houses (800), Harlescott Lane area; F. R. Dinnis, borough surveyor, Guildhall.

South Shields.—Houses (93) on the Whiteleas estate; John Reid, borough engineer.

Factory at the Laygate Street/West Holborn junction, for Rapide, Ltd., photographers, 5, Keppel Street; R. Collins, architect, St. Hilda Street.

Stockton-on-Tees.—Flats, maisonnettes and houses (372), Garbutt Street re-development scheme; T. H. Hartley, borough architect, 28, The Square.

Stopsley (Beds.).—Secondary school; county architect, Shire Hall, Bedford.

Sutton Coldfield.—New school between Woodington Road and Churchill Road; G. R. Barnsley, county architect, Shire Hall, Warwick.

Thatcham.—Dwellings (62), Stoney Lane; Gregory Housing, Ltd., 21, Farncombe Road, Worthing.

Tunbridge Wells. — Technical school for boys; R. Corben & Son, Ltd., West Boro, Hastings.

Tynemouth.—R.C. school; R. Bowey & Son, Great North Road, Newcastle-on-Tyne.

Wallsend.—Office block; J. R. Rutherford & Sons, Ltd., Minories Works, Jesmond, Newcastle-on-Tyne.

R.C. Church in Carville Road; Stanley Miller, Ltd., contractors, 17, North Street, Newcastle-on-Tyne.

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates do not clash with others already arranged.

Monday, 10th September

DUNDEE. — Mathers Hotel, 7.30 p.m. Incorporated Plant Engineers, Dundee Branch. "The Application of Work Study and Incentives to Maintenance," by D. Gardiner.

LONDON.—White Hall Hotel, Bloomsbury Square, 7.30 p.m. A.S.E.E. Central London Branch. "Motor Control Gear," by W. J. Johnson.

WEMBLEY PARK.—Century Hotel, Forty Avenue, 8.15 p.m. A.S.E.E. North West London Branch. Chairman's reception, followed by film.

Tuesday, 11th September

BOURNEMOUTH. — Grand Hotel, Firvale Road, 8 p.m. A.S.E.E. Bournemouth Branch. "Dissertation on the 13th Edition of the I.E.E. Regulations," by E. J. Sutton.

LONDON.—Connaught Rooms, 12.30 for 1 p.m. Electrical Industries Club luncheon. Speaker, Frank Owen.

MANCHESTER. — Engineers' Club, Albert Square, 7.15 p.m. Incorporated Plant Engineers, Manchester Branch. Chairman's "At Home."

TYNESIDE. — A.S.E.E. Tyneside Branch. 7 p.m. Visit to Stella power station.

Wednesday, 12th September

BRISTOL.—Grand Hotel, 7.15 p.m. Incorporated Plant Engineers, Western Branch. "Ventilation and Air-Conditioning," by J. R. Kell.

DUNDEE.—New Imperial Hotel, 15, Tally Street, 7.30 p.m. Institution of Production Engineers, Scottish Region, Dundee Section. "Materials Handling — with particular reference to Batch Production," by W. P. Kirkwood.

EDINBURGH.—North British Hotel, Princes Street, 7.30 p.m. Institution of Production Engineers, Scottish Region, Edinburgh Section. Ladies' night and film show.

HALIFAX.—Crown Hotel, Horton Street, 7.30 p.m. A.S.E.E. Halifax Branch. "Oils and Greases," by G. Stott, accompanied by films.

Thursday, 13th September

LONDON. — "Prince of Wales" Hotel, S.W.19, 8.30 p.m. A.S.E.E. South West London Branch. Film, "Fifth Electrical Engineers' Exhibition," and commentary by P. A. Thorogood.

NEWCASTLE-UPON-TYNE.—Roadway House, Oxford Street, 7 p.m. Incorporated Plant Engineers, North East Branch. "Light for Industry," by R. J. Fothergill.

Friday, 14th September

BIRMINGHAM.—Regent House, St. Philip's Place, Colmore Row, 7 p.m. Society of Instrument Technology, Midlands Section. "The Instrumentation of a Space Vehicle," by N. R. Nichol.

LONDON.—Feathers Hotel, Broadway, Westminster, S.W.1, 6 p.m. Electrical Trades' Commercial Travellers' Association. General meeting and supper.

EDUCATIONAL

The Northampton Polytechnic, St. John Street, London, E.C.1, has issued its prospectus of part-time courses in electrical engineering and telecommunications for the 1956-57 session, including those for the Higher National Certificate in Electrical Engineering and Part III examination of the I.E.E. Courses of lectures have been arranged on electric traction, railway electrical signalling, pulse techniques and automatic control (servo-mechanisms).

Courses arranged in conjunction with the Coal Industry Society to be held at the Sir John Cass College, Jewry Street, Aldgate, E.C.3, in the 1956-57 session include "Scientific Principles of Fuel Technology," "Solid and Gaseous Fuels" and "Domestic and Industrial Fuel."